MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

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Annual Report

For the Fiscal Year Ending June 30, 1946

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE

AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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YEGIAN, HRANT M., Agronomy

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*In charge †At East Wareham ‡At Waltham

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ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1945-46

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

Development of Statistical Data as Controls to Livestock Production Program. (A. A. Brown, Elaine M. Roberson, and Judith E. Rosenthal.) The field work phase of this project is completed and 941 farms in the "6% sample" have been classified by major source of income. These farms fell into the following classifications:

Dairy	239	Ducks, Turkeys, Broilers	13
Poultry	104	Miscellaneous	10
Poultry with other Livestock	30	Rural Residence with Livestock	198
Tobacco, potatoes, or crops	42	Rural Residence without Livestock	235
Vegetables	47	Estates	10
Fruit	13		

In statistical tests applied to the "6% Sample", the New England Crop Reporting Service Sample, and the "10% sample" of cow numbers, the differences between means fell below the 1 percent level of significance, indicating that the samples were drawn from the same population. The same results were obtained in the comparison of chicken numbers of the New England Crop Reporting Service sample and the "6% sample." The success of these tests indicates that the "6% sample" may be used to estimate livestock numbers with a satisfactory degree of dependability.

The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets. (A. A. Brown, Elaine M. Roberson, and Judith E. Rosenthal.) The objective under this project has been to develop a satisfactory series of market data for the five principal secondary milk markets for the State. Comparable and reliable price series concerning the decade since the beginning of public control are now available for these markets. Milkshed maps have been prepared for each market. Bulletins have been published covering Springfield and Worcester.

A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income. (A. A. Brown, Judith E. Rosenthal, and Elaine M. Roberson.) Statistical analysis of the tax and valuation data of the "10% sample" of dairy farms in Massachusetts has been completed. The results obtained from the compilation and analysis of data indicate excessive variation in assessment, which is fully as great among farms within a town as it is among the various taxing units. An analysis of the number of farms with more than one parcel of land, and the average number of parcels per farm show just how confused the assessment picture must be. For the entire sample, 61 percent of all the farms have more than one deed, while the average (number of farms) for the counties ranges from 39 to 94 percent. The average number of parcels per farm is 3.04. Statistically speaking, then, each farm is legally composed of three distinct units, requiring separate valuation, although from the *appraisal point of view*, good procedure might dictate either an over-all estimate

or a breakdown on a different basis. The figures obtained from one farm in an eastern county present this problem of variation rather dramatically. On this farm, one parcel of land is valued at $13,000 per acre, and another at $8 per acre!

In addition to the above, results indicate the following. There is an inverse relationship between real estate tax dollars per acre and the size of the farm by county averages. (However, this correlation does not take into consideration variations in types of land, said data being unavailable.) The average real estate tax for the whole sample is $211.54 with extremes of $26 and $1128. There is a very marked positive skew to the farm size data distribution. One half of all the farms have 84 acres or less, while the range in size for the whole sample is from 7 acres to 885 acres. An inverse relation was found between value per acre and farm size by county averages. Value per acre was $24 for the whole sample with a range from $2 to $382; the range for county averages was from $16 to $41. As far as could be determined from the data available, there is no relation, inverse or otherwise, between valuation and tax rate. The modal class for house valuations was $1000 through $1499, while one half of all the farms had houses valued from $200 through $1617. The range in house valuation for the whole sample was $15,800. Cow units equal 78 percent of total livestock units, while cow valuation represents 85 percent of total livestock valuation. There is a high modal concentration in the $50 to $64 value-per-grade-cow group with the wide range in value per cow of $110. Real estate taxation and personal property taxation tend to move together; the average tax paid on personal property was 34 percent of the tax paid on real estate.

Production Efficiency on Dairy Farms in Massachusetts. (C. R. Creek.) According to farm management records, labor efficiency increased almost 20 percent in the ten years from 1934 to 1944 for the same 50 dairy farms, on the basis of productive work units per man. On these identical farms the milking herd increased from 20 to 26 cows, cropland increased by 8 acres and pasture by 15 acres, while the total labor force remained the same at 30 months of hired, family, and operator labor per farm. The most important factor in this greater efficiency of labor was the increase in labor-saving machinery on these farms. The number of farms with milking machines increased from 23 to 43 in these ten years and those with electrical milk coolers from 20 to 45. The farm work was mechanized with tractors on 40 farms in 1944 compared to 19 ten years earlier. Trucks were listed on 40 farms compared to 30 farms in 1934. The number of ensilage cutters on farms increased from 26 to 35, side delivery rakes from 6 to 21, and hay loaders from 6 to 23.

Milk production was also more efficient in 1944, with 365 more pounds of milk produced per cow on slightly less grain, hay, and silage. Milk production increased from 2.6 to 2.8 pounds for each pound of grain fed in these two years.

In the period of low prices in 1933–34 the cash farm cost of producing milk was about $1.39 per hundredweight, the price received was $2.27 per hundredweight, and net farm income was $687 per farm. In the high price period of 1943–44 the cash farm cost of production was about $2.34 per hundredweight, the price received was $4.09 without the feed subsidy, and net farm income was $2524 per farm for the same 50 farms. The margin of prices received over prices paid was greater in the period of higher costs of production. The relationship between prices was the important factor in higher returns rather than the absolute prices or costs.

Loan Performance on Low Income Farms in Massachusetts. (C. R. Creek.) Another year of high prices and generally high crop yields enabled nine of sixteen active borrowers from the Farm Security Administration in the Connecticut

Valley area to repay their crop loans in full from the 1945 production of tobacco, potatoes, and onions. Only six of 23 borrowers with livestock and livestock-crop loans paid their loans in full in the past year. Livestock loans have a longer period for repayment while crop loans are generally for one year.

Loans have been repaid on 134 of the 202 farms for which loans were made. Loans were defaulted on 5 percent of the farms and 13 percent are now classified as collection cases since these borrowers are no longer engaged in farming. Only 15 percent of the total number of farms since 1936 are now considered as active cases and less than one-half of these received supplementary loans in 1946. New loans in 1945–46 were chiefly to start potato growing and poultry farming.

Generally the cash-crop farms have shown a higher rate of repayment of loans and a lower proportion of collection and defaulted loans. The highly profitable tobacco and potato crops of the past three years have furnished income to pay off old debts and provided a surplus to finance farm operations for another season. Borrowers on livestock farms generally have met scheduled payments, but few have made advance payments on their obligations.

Methods and Costs of Improving Land on Massachusetts Farms. (C. R. Creek and J. F. Hauck.) The cost of boulder removal from crop and pasture land on Massachusetts farms varied from $40 to $100 per acre for the bulldozer charge under normal conditions. Some records have shown a cost of $175 per acre for boulder removal where a small bulldozer was used and many large boulders were pushed out. On cropland where scattered large boulders were removed the cost was about $35 per acre in one instance where 55 boulders were removed from 2.5 acres. Costs were generally less per acre where larger bulldozers were used, although the rate per hour was greater.

Costs of removing stone walls from farms ranged from 25 to 50 cents per linear foot under normal conditions, according to records obtained in 1945. Costs were highest where the stones were loaded on trucks with a gas shovel and hauled to a swamp for disposal. The cost was less where a trench was dug with a gas shovel and a bulldozer used to push the walls into the trench and cover the stones to a depth of three feet with soil. Costs were lowest where a wide and shallow trench was made with a bulldozer, the stones pushed in and spread over an area about eight feet wide and then covered with one to two feet of soil to make a dry roadway through orchards or pastures.

It is difficult to justify the removal of boulders and stone walls in order to have larger, more open fields for the use of labor-saving machinery, although many farmers contend that the cost will be repaid in seven to ten years in the lower cost of production which will result from mechanization of crop production.

A method of land improvement which has increased greatly in recent months is the blasting of drainage ditches by the Soil Conservation Districts. Although soil conditions vary between farms, the cost of dynamiting has ranged from 8 to 15 cents per linear foot for a ditch two to three feet deep and five to seven feet wide. This size of ditch with the natural slope of the land will drain many marsh and swamp areas to increase the acreage of pasture and hay land on farms. In some areas the main drainage system will be dug with a shovel or dragline through the cooperation of the Soil Conservation District and lateral ditches will be constructed by each farmer on his farm. Cooperative effort is necessary in most instances to obtain a suitable outlet for drainage ditches.

Methods and Costs of Harvesting Hay on Massachusetts Farms. (C. R. Creek.) Buck rakes mounted on a heavy car or truck chassis are an efficient means of harvesting hay when the distance from field to barn is not over one-fourth mile. The weight of load ranged from 500 to 800 pounds for these buck

rakes and the hay was loaded from both the swath and windrow in various instances. Buck rakes are most satisfactory on small farms with near-by hay fields and on farms with a small labor force for hay harvesting.

On many farms the labor-saving possibilities of the pick-up baler for hay have not been developed into an efficient method of hay harvesting. On most farms the bales are dropped on the ground in the field and must be loaded on a wagon or truck by hand. At the barn the bales are unloaded by hand, lifted into the mow and carried to final storage space. This method was costly, inefficient, and fatiguing for these larger farms where field balers were used.

On one fairly large farm with a 50-cow herd and a total of 75 animal units, the job of harvesting hay was made very efficient and non-fatiguing by using other equipment with the field baler. A one-man baler was used in the field with a low-wheel, rubber-tired wagon attached to the baler so that the bales were loaded directly on the wagon from a ramp built on the baler. A small tractor was used to haul the loaded wagons to the barn where an elevator powered by an electric motor was used to unload bales into the barn. This elevator was mounted on a wagon chassis and could be moved to small doors cut in the side of the barn at 25-foot spaces so that bales were carried only a short distance in the barn mow. The haying operation was continuous on this farm since two low wagons were used. One was loaded at the rate of three bales per minute while the other was hauled to the barn, unloaded, and returned to the field in the same length of time. The crew of five men (two in the field, two at the barn, and one hauling) under normal conditions could bale, load, haul, unload, and store a load of 51 bales every 17 minutes. For a continuous operation this amounts to almost one ton of hay per man per hour with a minimum of effort.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Evaluation of Additions of Sodium Nitrate and Ammonium Sulfate when Applied to the Soil during the Late Summer Preceding the Spring when Tobacco Is Planted. (Walter S. Eisenmenger and Karol J. Kucinski.) It has been observed that tobacco grown after crops of corn, timothy, or clover frequently did not yield well, probably because of a deficiency of nitrogen at the time when certain organisms were active in decomposing fibrous tissue. Different amounts of nitrogen — 50, 100, 200, 300, and 500 pounds per acre of nitrogen in the form of sodium nitrate or ammonium sulfate — were applied to plots on which corn and grass had previously been grown, for the purpose of ascertaining to what degree this would prevent the usual bad effects of these crops on the succeeding crop of tobacco. The nitrogen was applied sufficiently early in the season to permit the warm weather to facilitate the action of decomposition agencies.

In general, the yield per acre and the quality of the tobacco increased with each increment of sodium nitrate applied to plots which had had a preceding crop of grass. These increases were larger where calcium carbonate was used as a supplement than where calcium sulfate was so used. Generally the plots on which grass was plowed under were better than the plots from which the grass was harvested as hay before plowing. No definite correlation could be established on the series of plots which had the calcium sulfate supplement and on which the hay was harvested before plowing.

No significant relationship was found in the yields or quality of tobacco grown on plots where mature corn had been plowed under in the fall. Both, however, were decidedly lower on the series of plots from which the corn had been harvested

before plowing and were poorest on plots on which corn was allowed to stand over winter before plowing. Where nitrogen had been added before plowing, there was considerable increase both in yield and in quality; but the deleterious effects of corn on tobacco may not be entirely alleviated by the use of nitrogen.

The yields of tobacco on the ammonium sulfate plots were greater than on the nitrate plots, but the quality of the tobacco was inferior.

The Absorption of Chemical Elements by Food Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) The experiment was set up to compare the intake of elements when used singly and in pairs. The intake of calcium and magnesium was studied as well as the influence of the copper ion on the intake of magnesium and the movement of magnesium in the plant.

Magnesium added to the soil caused an increase of magnesium in the plants in all instances. When calcium was added to the soil, most of the plants studied contained more calcium but approximately a fourth showed no increase.

In water solutions copper ions lowered the transfer of magnesium. In the field this was not observed, probably because of the small amount of copper added (75 p.p.m.) and the buffer action of the soil. The change in the composition of seeds from plants under varied conditions of ion application was insignificant.

There seemed to be a tendency for the calcium content of plant tissue to be increased when copper was added to the soil. No explanation can be made of this unusual behavior.

The magnesium content and, to a lesser degree, the calcium content of foods and feeds can be increased by application of the salts of these elements to the soil. In the seedling stage, the transfer of magnesium from the seed and the water medium to the aerial portion of the plant was diminished by as small an amount of copper as one-half part per million.

Magnesium Requirements of Certain Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) Work on this project included study of the relationship of seed plant development and the need of plants for magnesium, as well as the relation between intake of magnesium and the supply of the element in the soil. This part of the project was designed to ascertain whether plants which readily show signs of magnesium deficiency take up more or less magnesium when an ample supply is present in the soil than plants which do not show symptoms readily.

Plants vary greatly in their reaction to soils of low magnesium content, and plants of a lower order of development show the deficiency more quickly than plants of extremely high development. Thus the buttercup (Ranunculus), the mallows, geraniums, elms, anemones, buckwheat, rhubarb, cabbage, and tobacco always react to low magnesium soils; while plants like the asters, dandelions, sunflowers, ragweed, lamb's-quarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*), and the grasses do not show any symptoms of magnesium deficiency when grown on the "deficiency" plots. There are two conditions where the above does not hold. First, when plants have been changed by selection or plant breeding, there is no certainty that these species will react at all to soils of low magnesium content. Second, and less frequently, certain plants such as the portulaca and blackberry, for example, when grown in low magnesium soil show deficiency only in subnormal growth and not through chlorosis. Some plants, as the mallows and buttercups, normally take up comparatively little magnesium, and their magnesium content, compared with that of other plants, is low. There is evidence that such plants react more quickly to low mag nesium soils.

The ability to recognize the plants which are not tolerant to low magnesium content of the soil would afford a chance to correct this condition when the need

arises; for it is in the *early* stages of growth that magnesium is required and applying salts of magnesium *after* the symptoms appear is generally much too late.

Long-Time Fertility Tests. (Karol J. Kucinski, Walter S. Eisenmenger.) Fifty to sixty years ago a series of test plots was established to study the effects on the soil and crops of a long-time fertilizer program. Where the plots were treated singly with either nitrogen, potash or phosphorus, the nitrogen plots showed the greatest response. Yields of hay ranged 2 to 2.5 times as great on plots receiving lime as on those not limed. Rabbits fed grass grown on limed plots made greater growth than rabbits fed grass grown on unlimed plots. Similar results were obtained where cabbage was used to feed the rabbits.

Sunflowers and Their Possibilities. (Karol J. Kucinski and Walter S. Eisenmenger.) Although the 1945 growing season was generally unfavorable for most farm crops because of abnormal rainfall, sunflowers did remarkably well. The Mennonite and Sunrise varieties, which are considerably shorter than the Mammoth Russian, yielded less seed, but this disadvantage was counteracted by less breakage of the stalks in wind storms. The wet season was very conducive to weeds, yet the sunflowers had no difficulty in shading out all weeds growing in the plots. Yield studies indicate that sunflowers will respond to liming. Heavy fertilization of soil of good fertility tends to produce abundant vegetative growth with the possible risk of lodging, especially during wind storms.

Soil Conservation Research Projects. (Karol J. Kucinski and Walter S. Eisenmenger.)

Physical and Chemical Properties of Wind-Blown Soils. Laboratory and field tests have been in progress for several years to determine why certain soils are subject to wind erosion while others are not. A specially constructed wind tunnel was used in the laboratory to supplement field observations.

Climatological data were studied to ascertain what elements of climate influenced dust storms as they occurred naturally in the Connecticut River Valley. It was found that rainfall has only a very small effect on retarding wind erosion; while the months of January and February, the period of greatest snowfall, usually have fewest dust storms. A direct relationship exists between known occurrence of dust storms and the monthly prevalence of winds, particularly those of over 10 miles per hour. The data show that wind velocities increase in the afternoon. This corresponds with the observation that nearly all dust storms occur in the afternoon.

In the comparison of the physical and chemical soil tests with wind tunnel studies, it was found that the more sandy the soil, the lower was the initial velocity at which it began to blow. The initial velocity was generally lower for frozen soils than for air-dried soils. For most of the soils studied, the losses were greater at low wind velocities for frozen soil than for air-dried soil; while at the higher wind velocities, the air-dried soils were more erodible. It was found that the organic matter content, the maximum water-holding capacity, the moisture equivalent, and the hygroscopic coefficient of the soil had a direct relationship to wind erosion. It was further noted that the higher the settling volume of a soil, the lower were its losses in the wind tunnel. A ripple or wave pattern appeared on the surface of sandy soils (non-agricultural) when blown in the wind tunnel, while agricultural soils showed streaks.

Soil moisture studies show that wet soil will not blow at any wind velocity. The very top thin layer of particles is relatively dry before it wind erodes, while sublayers of soil may be relatively moist. Sandy soils blow sooner after a rain because the capillary action is broken at the very surface of the sandy soil.

Dust collected showed 0.46 percent moisture, while the parent soil had a 26.0 percent moisture content.

Where the formation of aggregates in dry soils was increased by chemical treatment, their tendency to blow was decreased. Soils treated with ground limestone, burnt lime, urea, and lithium carbonate showed decreased losses with the treatments in the order mentioned; the finer the texture of the soil, the more pronounced the effect. Calcium and sodium silicates tended to bind the soil into aggregates and so reduced soil losses. Organic matter when applied in the form of raw lignin lowered the initial velocity at which the soils began to blow and also increased the rate of wind erosion. The lignin used was not comparable to soil humus or organic matter. The organic matter produced in a soil from the decomposition of yearly applications of sawdust reduced the amount of wind erosion and also raised the initial velocity at which the soil began to blow. Soil taken from under a manure pile dried into a coarse lumpy condition which was quite resistant to wind erosion.

A study of the deflocculating effects on the soil of the mono-valent elements in period one of the "Periodic Tables of Atoms" showed that, upon drying, the soils had experienced an aggregated condition which increased in the following order of the elements tried: lithium, sodium, potassium, rubidium. The pH value of the soils was greatly increased by this chemical treatment. The rate of increase of the pH values was in the reverse order to the aggregating effect.

To study the rate of wind erosion on fields of various crops and the relation of the cultural practices to dust blowing, a portable dust collector was developed. These studies show that the soil blows more on areas growing vegetables like onions and lettuce than on areas used to grow tobacco and potatoes. There was a direct relationship between pH and amount of dust collected. These observations were confirmed in the wind tunnel studies where soils from two experimental plots were tested. Soil from a plot having a yearly application of limestone had a pH of 6.9 and eroded considerably more than soil from a plot which had not received any lime and had a pH of 4.8. It is believed that the flocculating effect of continuous liming has produced a soil surface condition more susceptible to wind erosion.

Use of Snow Fencing in Controlling Wind Erosion. The results of this test, which was described in detail in the annual report of 1944–1945, were not very conclusive this year owing to the lack of dust storms during the exceptionally wet season of 1945. The anchorage of the snow fencing with iron pipes, 4½ to 5 feet long, driven 18 inches into the ground and spaced a rod apart, held the 4-foot-high lath fencing throughout the entire season. Frost action did not tend to heave the anchorage out of the ground.

Black Root Rot of Tobacco. (C. V. Kightlinger.) Strains of Havana Seed tobacco that yield well under black root rot promoting conditions often produce tobacco that is not fully acceptable to all of the tobacco trade when grown under favorable producing conditions. Therefore an attempt is being made to breed strains which will produce tobacco of acceptable type and quality in profitable amounts under both these growing conditions.

Havana K1 and Havana K2 and other new strains thus far produced are now being grown commercially to ascertain their suitability for general use in the Connecticut Valley. These strains yield well under different growing conditions; and so far, the tobacco produced seems to be receiving greater approval for type and quality by the tobacco trade than that produced by Havana 211 and other previously produced strains. It is too soon, however, to know whether these new strains will be entirely satisfactory.

Meanwhile, work is being done to effect further improvements: first, by selecting the most desirable plants within the strains already produced to improve habits of growth as well as type and quality; and second, by breeding entirely new strains.

Brown Root Rot of Tobacco. (C. V. Kightlinger.) Ordinarily, but not always, tobacco grown immediately following corn, grasses, and a few other crops develops brown root rot in some degree, in the Connecticut Valley. It is probable that more than one factor may be responsible for this irregular occurrence of the disease; but it is natural to suppose that soil fertility may be one of the most important. With this in mind, experimental work is now in progress, as follows:

1. Crops known to produce brown root rot promoting soil conditions under usual fertilizing practices are being grown with more than the usual amounts of fertilizer, to determine what effect this will have on the following crop of tobacco. Results are not yet available.

2. Different amounts of fertilizer are being used on tobacco following crops known to produce brown root rot promoting soil conditions, to determine whether fertilizer can be so used as to prevent the development of the disease following these crops. Results are not yet available.

3. Tobacco is being grown continuously on the same land, with inadequate fertilization, to ascertain whether the disease will develop under these conditions. It has been definitely determined experimentally that brown root rot will develop, in moderate degree at least, on tobacco that is grown continuously on the same land under certain inadequate fertility conditions. This result, in connection with the well-known fact that brown root rot may be overcome, in the Connecticut Valley at least, by growing tobacco continuously on brown root rot promoting land for three or four years under usual tobacco fertilizing practices, suggests that malnutrition may be important in the development of the disease. Further tests are necessary.

Control Measures for Mildew of Tobacco. (C. V. Kightlinger.) In experimental work to test the comparative effectiveness of different materials in the control of mildew of tobacco in seedbeds, Fermate and bismuth subsalicylate used in recommended concentrations gave complete control of the disease in 1946. Mildew developed in moderate severity in the untreated check. The materials were applied at weekly intervals with sprayer at 150 pounds pressure. Eight applications were made throughout the season, beginning May 3, before any cases of mildew in tobacco seedbeds had been reported.

Potato Seed Treatments. (C. V. Kightlinger and H. M. Yegian.) Seed potatoes of seven varieties grown regularly in the State (Chippewa, Katahdin, Earlaine, Sebago, Irish Cobbler, Green Mountain, and Russet Rural) were treated with cold mercuric chloride plus acid, cold formaldehyde plus acid, Semesan Bel, Sanoseed, Fermate, and Spergon, to ascertain the relative tolerance of the varieties to disinfecting treatments and the comparative effectiveness of the treatments in the control of scab and rhizoctoniose.

Mercuric chloride and formaldehyde caused little injury to tubers of the Irish Cobbler, Green Mountain, and Russet Rural varieties; moderate injury to tubers of the Katahdin, Earlaine, and Sebago varieties; and more severe injury to tubers of the Chippewa variety. These treatments caused reductions in stands of potatoes in the field ranging from slight, in the case of Irish Cobbler, Green Mountain, and Russet Rural; moderate to heavy in case of Katahdin, Earlaine, and Sebago; and severe in the case of Chippewa. Semesan Bel, Sanoseed, Fermate, and Spergon caused no noticeable injury to the tubers of any of the varieties before planting; but Semesan Bel and Sanoseed had some detrimental effects on

the stands of Katahdin, Earlaine, and Sebago, and worse effects on the stands of Chippewa.

None of the seed treatments seemed to increase the vigor of plants. Careful examination of growing plants and later inspection of mature tubers after digging, showed no consistent differences in the amounts of rhizoctoniose on potatoes grown from treated and untreated seed. No scab developed in any of the plots, not even in the control grown from untreated seed.

On the basis of experimental results obtained in 1945 as well as the two previous seasons, disinfecting seed treatments are of doubtful value as control measures for rhizoctoniose of potatoes in most potato land. Although no scab developed even in the control plots, it is reasonable to believe that disinfecting seed treatments would be of doubtful value in the control of scab also.

Evaluation of New Lines of Irish Potatoes for Resistance to Scab and Rhizoctoniose. (C. V. Kightlinger and H. M. Yegian.) Newly developed lines of Irish potatoes were tested for comparative resistance to scab and rhizoctoniose in informal cooperation with the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture.

Several of the new lines were apparently highly resistant to scab. A few of the lines showed no traces of scab when the Green Mountain control scabbed so badly that its tubers were utterly worthless. A few of the lines showed evidence of having considerable resistance to rhizoctoniose. Other lines bore enough small sclerotia on their tubers to interfere greatly in estimating the comparative scab resistance of the lines. There were not enough plants to spare any for examination in the growing stage to ascertain their resistance to rhizoctoniose more completely. More information about the comparative resistance of these lines to rhizoctoniose is needed.

Potato Variety Trials. (Karol J. Kucinski, Ralph W. Donaldson, Walter S. Eisenmenger.) Because the 1945 growing season was abnormally wet, the yields obtained in the potato variety test were much lower than in former years, ranging from 273 bushels per acre for Sebago to 107 bushels for 47102 Teton.

Based on yields of marketable size, the ranking of potato varieties in the Experiment Station plots during the season of 1945 was Sebago, Cayuga, 055, Red Warba, 627-103, Green Mountain, Mohawk, Chippewa, Pawnee, Katahdin, 46952, Cobbler, Houma, Russet Rural and 47102 Teton.

Corn Improvement Program. (Hrant M. Yegian.) Seventy-five varieties, mostly hybrid seed corn supplied by state experiment stations and private seed companies were tested for their general adaptability and yield. In the early maturity group, Wis. 412A and Mass. 62 produced the highest yield of shelled corn per acre (90 bushels). Wis. 643 was the highest producing full-season silage corn. The very late maturing varieties produced somewhat more silage per acre, but this consisted mostly of stalks and leaves. Therefore, the quality and feeding value of the silage would not be as high, pound for pound, as that from varieties which produce a higher proportion of ears which are in the dough or pre-dent stage before the killing frost. With somewhat earlier maturity it is possible to ensile before the usual mid-September frost or hurricanes which do great damage to silage corn. The results of the 1945 field tests are published in mimeographed form and are available upon request.

Fifty-five single crosses involving all possible combinations of eleven inbred lines in the early maturity group were tested. On the basis of this test, a few of the promising predicted double crosses were made in the greenhouse during the winter and these are being tested in the field during the 1946 season. The double cross (CC4xCC8) x (Q83xA96) promises to be an especially good, early-maturing field corn.

Among the thirty-six experimental double crosses there were two especially good mid-season hybrids. These are being tested further prior to their release to the farmers.

The results of yield tests on three rates of planting on three different dates were not very reliable. Excessive rainfall in the spring and poor drainage of the field where the test was carried on caused wide discrepancies among the replicates.

A set of fifty-five early maturing single crosses was made here last year in cooperation with the northeastern corn breeding program. These are being tested for their general adaptability in the northeastern region.

Onion Breeding. (Hrant M. Yegian.) In 1945 a number of male-sterile Early Yellow Globe and Ebenezer crosses supplied by Dr. H. A. Jones of the United States Department of Agriculture were tested. Some of this material was very promising, particularly one backcross which made a vigorous growth, was of nonbolting globe type, and had exceptionally uniform skin color and bulb shape. A number of bulbs of male-sterile lines have been planted in isolated plots and are being pollinated with selected strains of Ebenezer lines in order to determine the relative combining ability of the various strains and lines used. The resulting hybrids will be tested to ascertain their adaptability in the Connecticut Valley.

Preliminary evidence tends to show that application of borax at the rate of 30 to 50 pounds per acre on set-producing fields may have subsequent beneficial effect on the keeping quality of the stored onions. Most onion soils have a pH value of 6.0 to 6.5, which is maintained by the application of one to two tons of limestone per acre, every two or three years. Since boron starvation occurs more frequently on heavily limed soils than on acid soils, it seems advisable to apply sufficient borax to safeguard against this difficulty.

Various fungicidal chemicals, Fermate, Puratized N 5 E, Isothan Z-15, Wettable No. 604, Wettable Spergon, and Dithane D 14, were tested for the control of storage rot of onions. Preharvest spraying of plants—three applications at weekly intervals prior to pulling—dipping the bulbs from unsprayed plants, soon after they were harvested, in concentrations recommended by the manufacturers of these chemicals, did not give any control of rot in storage. The best and most weekly intervals prior to pulling—or dipping the bulbs from unsprayed plants, soon after they are harvested, in concentrations recommended by the manufacturers of these chemicals, did not give any control of rot in storage. The most practical method known for reducing losses in storage is to store only sound onions in cold storage under controlled conditions at 32°-35° F. and low humidity.

Pasture Renovation Experiments. (Wm. G. Colby.) Work was begun in 1943 in cooperation with the U. S. Department of Agriculture Regional Pasture Laboratory in State College, Pennsylvania, for the purpose of studying practical methods of renovating depleted or "runout" pasture land by tilling, fertilizing, and reseeding. Experiments were laid out on fields which differed widely in topography, character of native vegetation, degree and nature of stoniness, and soil drainage relationships. This was done intentionally; for, as the work progressed, it became increasingly obvious that different conditions may require widely varying methods of procedure to secure the most effective results. Following is a summary of some of the observations which have been made during the course of these experiments.

Degree of Stoniness. It is doubtful whether attempts should be made to renovate stony land until most of the surface stones, six inches in diameter or larger, have been removed. If many stones of this size or larger are exposed, it is extremely difficult to work up a seedbed. If a bog harrow is used, for example, the machine tends to bounce from rock to rock and in so doing loses much of its effectiveness as a tillage instrument. Repeated working of the land is necessary to secure a satisfactory seedbed. Excessive wear is caused not only on the harrow but on all other machines which may be used.

Stone Removal. In the hands of an experienced operator a large caterpillar tractor with regular bulldozer attachment is probably the most efficient and practical means of removing large stones. Rocks weighing from a few hundred pounds up to several tons can be removed in the course of a few minutes. A bulldozer was also found to be useful in leveling off uneven "hummocky" land by dragging the blade and operating the machine in reverse. This breaks down the hummocks and tends to tear them apart.

The removal of smaller stones is a more difficult problem. There seems to be no other way except to pick them up by hand, and this is a slow, arduous operation. If there is grass growing, many stones become so imbedded in the sod that the use of a bar is necessary to pry each one loose. A preliminary disking with a bog harrow after the large stones and boulders have been removed will help to dislodge many of the smaller stones and thereby facilitate their removal.

Character of Native Vegetation. The effectiveness of different tillage implements is greatly influenced by the nature and quantity of native vegetation.

1. *Moss cinquefoil association:* a bog harrow is particularly effective in destroying this type of cover. One thorough disking is usually sufficient.

2. *Grass sod:* The destruction of a grass sod can be accomplished with a bog harrow, but several diskings are usually required. So far, disking at intervals of one to two weeks during midsummer has been the most effective means of destroying bluegrass and bentgrass sods. If operations are begun in July, a satisfactory seedbed can usually be prepared for seeding in late August. If seeding is delayed until the following spring, there may be considerable recovery of the native grasses.

3. *Herbaceous woody plants (hardhack, meadow sweet, ground pine, laurel, etc.):* If the proportion of woody plants is high, a bog harrow is not particularly effective unless most of the native growths are first mowed and removed. The mowing operation, too, is most successful if carried out in midsummer. Where the land is not too stony or rough, a brush-breaker plow can be used satisfactorily, in which case mowing the native vegetation may not be necessary.

Time of Seeding. Thus far late-summer seedings have been much more successful than spring seedings. This may have been partly due to the abnormally warm weather early in the spring of 1944 and again in 1945 which was unfavorable to new seedings. Probably more important than unusual weather conditions, however, were the difficulties encountered in preparing a well-consolidated seedbed with so much undecomposed plant material present. These soils tended to dry out more quickly than regularly cultivated soil until some of this raw organic matter had broken down. It was observed that dry weather following spring seedings was more damaging than dry weather following fall seedings.

Studies on the Causes of Winter Injury to Ladino Clover. (Wm. G. Colby.) Although most stands of Ladino clover show evidences of winterkilling every spring, injury is much more severe after some winters than after others. In the summer of 1943 a field experiment was laid out with the objective of studying some of the factors associated with this trouble. Seedings were made of Ladino clover alone and in combination with orchard grass (S 143), smooth brome grass (northern strain), meadow fescue (Svalof Early), and timothy. Different cultural treatments were also included.

It was not until the spring of 1946, when Ladino clover stands generally suffered extensive winter injury, that significant differences between treatments were evident. The plots which were mulched with straw showed no injury

whatsoever. The straw had been applied on November 16 at the rate of 3½ tons per acre and removed the following April just before active spring growth started. The clover in all other plots (with the exception of part of one manure plot which accidentally received a very heavy application of cow manure) was severely injured. On this one small section, the manure application was so heavy that it actually served as a good mulch. Where cow manure was applied at a lighter rate (10 tons to the acre), winter injury was severe.

The Ladino clover in all plots appeared to be vigorous and healthy at the time the manure and straw mulch applications were made in November. Since all plots were covered with snow a few days later, it seems probable that most of the injury occurred in early spring after the snow had melted. There were several days during the latter part of February and the first part of March when winds of record or near record velocity were experienced. It is suggested that much of the winter injury to Ladino clover is actually spring injury occurring after the snow melts, and is caused by the drying action of heavy spring winds on the fleshy Ladino stolons.

Trials with New Oat Varieties. (W. G. Colby.) Heavy summer thunder showers caused serious lodging in many varieties included in the oat variety test carried on in cooperation with the U. S. D. A. Division of Cereal Crops. The varieties Vicland and Tama, which had given high grain yields in previous years, lodged badly and yielded only 47 and 43 bushels per acre respectively. Clinton and a new variety, Mindo, both of which matured about the same time as Vicland, lodged only slightly and yielded 83 and 79 bushels per acre. Ajax and Bention varieties, which matured about five days later than Vicland, produced yields of 84 and 80 bushels per acre.

DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

A Study of the Mineral Elements of Cows' Milk. (J. G. Archibald.) As a result of extensive study of methods for the determination of cobalt in milk, in which Dr. Beeson of the U.S.D.A. Regional Laboratory at Cornell University collaborated, it was decided last summer that further progress could not be made with existing laboratory facilities. A room has, therefore, been remodeled and re-equipped for this and other special "trace" element work, and active work on the project is being resumed.

The Effect of Feeding Synthetic Thyroprotein to Milking Cows. (J. G. Archibald.) Results for the winter season of 1944–45 have been published.[1] The work reported was mainly a study of the effects of the hormone on milk composition. The most important effect was a considerable and rather consistent decrease in casein, and a roughly proportional increase in lactalbumin and globulin. Changes in fat content of the milk were not consistent.

Since these changes may be of considerable significance if characteristic of the action of the hormone on cows in general, it was thought advisable to repeat the work in a more intensive manner. This was done in the winter of 1945–46, with a smaller number of cows (6) but using the same individuals throughout and trebling the number of milk samples taken. This later work is in general agreement with the earlier results: the effect of the hormone on milk composition was not consistent, but the tendency for the casein of the milk to be decreased was

[1]Journal of Dairy Science, Vol. 28, No. 12, pp. 941-947, December 1945.

still apparent. Individual cows, even within a breed, varied widely in their response to the hormone stimulus. Holstein cows in general were less responsive than Ayrshires, Guernseys, or Jerseys. Live weight decreased sharply at first, but after a few weeks increased slowly, even while the hormone was still being fed. Respiration and pulse rates in general were accelerated somewhat, but individual animals showed great variations in these respects.

The Effect of Massive Doses of Irradiated Yeast on Incidence of Milk Fever in Dairy Cows. (J. G. Archibald.) This project is a part of a more comprehensive one, the other phases of which were terminated several years ago. This particular phase has been kept active but data have been slow in accumulating because of the limited number of cows (6) in the college herd suitable for the study; that is, having a previous history of milk fever.

The procedure consists in feeding one million units of vitamin D in irradiated yeast daily per cow for one month previous to calving. As indicated above the yeast was fed only to cows having had milk fever previously. In five out of the six cases, cows receiving irradiated yeast did not develop milk fever; also, when used as controls in a subsequent lactation (that is, not fed the yeast), two out of three of these cows did have milk fever again. A fourth cow, not intended as a control but refusing the grain with which the yeast was mixed, makes it three out of four cases in this latter category. Especially worthy of note is the case of one cow which responded to the yeast feeding in two successive lactations, but reverted to her original status when used later as a control.

Further cases will be studied before final conclusions are drawn; but so far as these cows are concerned, the treatment appears to have been a definite value.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Bacteriological Studies of Rural Water Supplies. (James E. Fuller.) This study was a comparative differentiation of coliform bacteria from privately owned rural water supplies at several temperatures: 37° C., as provided by the Standard Methods of Water Analysis of the American Public Health Association; 44° C., as employed by the British practice; and 46° C., as employed in the Eijkman test. To provide an intermediate temperature between A.P.H.A. Standard Methods and the British system, 40° C. was also employed in the study. The tests employed were the indole, methyl-red, Voges-Proskauer, and sodium citrate tests, as directed in the A.P.H.A. Standard Methods. The results warrant the recommendation that the methyl-red test at 44° C. be employed for effective differentiation of sewage-type (fecal) coliform bacteria from surface-wash (soil-type) coliform bacteria in the testing of raw waters from wells, springs, and streams. The study has been completed and results published.[1]

Relation of Chloramine-resistant Bacteria to Milk Supplies. (James E. Fuller.) The isolation and study of bacteria surviving chloramine treatment in a public water supply have been reported and published.[2] Since the supply in question, the others like it, serve milk-bottling plants and some dairy farms, it appeared to be desirable to determine the effect of these bacteria on milk supplies. Results indicate that all of the bacterial cultures isolated were capable of

[1] Journal of Bacteriology, Vo. 51, No. 4, pp. 457-464, April 1946.

[2] Journal New England Water Works Association, Vol. 58, No. 2, pp. 89-100, June 1944; and Vol. 59, No. 3, pp. 244-251, September 1945.

multiplying in milk and spoiling it, even at the normal operating temperature of an electric refrigerator. All of the cultures were killed effectively by pasteurization except those that formed spores. These was as expected. This project is completed.

Study of Septic Tank Efficiency. (James E. Fuller.) In this study three septic tanks of identical size were supplied with sewage from one of the college dormitories. The rates of supply to the three tanks were so regulated that sewage was retained in them 24 hours, as usually recommended, 12 hours, and 8 hours, respectively. The object was to determine whether the shorter retention periods would result in greater operating efficiency in the tanks. Results showed that the conventional 24-hour retention was superior to the shorter periods on the basis of the following evidence: (1) the coliform index of the effluent was lower for the 24-hour period than for the shorter periods; (2) the biochemical oxygen demand results favored the 24-hour period as compared with the shorter periods; (3) at the end of three months of operation for two consecutive seasons, the thickness of scum in the normal tank was about 2 inches; while in the tanks with 12-hour and 8-hour retention periods, thicknesses of 11 and 13 inches respectively resulted, which would have plugged up the outlets of these tanks if they had been constructed with the usual outlets. An extension of the project was secured to permit a study of the permeation of coliform bacteria into the soil of the disposal field, and of the accumulation of nitrates in the soil. This work is in progress now.

Effectiveness of Commercial Surface-active Agents for Use as Household Cleansing Agents. (James E. Fuller.) Some 42 agents have been examined to determine their germicidal power. About one-third of them were found to be very effective, and several others were moderately effective. Experiments are now under way to devise a procedure for evaluating the efficiency of these agents on a sliding scale on the basis of variations of time and concentration, preparatory to investigating the effect of organic matter, acids, and alkalis on the germicidal power of the agents.

Types of Microorganisms Involved in the Spoilage of Home-canned Foods. (Ralph L. France.) This is a new projedct an work has only been begun. To date no results are available for report.

Laboratory Service, July 1, 1945, to June 30, 1946. (James E. Fuller.)

Milk samples, bacteria counts	171
Ice cream samples, bacteria counts	76
Water samples, bacteriological tests	140
Total	387

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.)

The Dutch Elm Disease Problem. As of July 1, 1946, the Dutch elm disease, caused by the fungus *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 182 trees in 28 municipalities in Massachusetts, as follows:

	1941	1942	1439	1944	1945	1946	Totals
Berkshire County							
Alford	1			2		4	7
Dalton					1		1
Egremont		3	2	3		1	9
Great Barrington		1	1	6	6	13	27
Hancock					1		1
Lanesboro						1	1
Lenox					2	1	3
Mount Washington				1			1
New Marlborough						17	17
Pittsfield				3	5	2	10
Richmond					9	8	17
Sandisfield				1			1
Sheffield		1		5	2	13	21
Stockbridge				2		12	14
West Stockbridge			1		1	11	13
Williamstown					1		1
Hampden County							
Agawam					1		1
Chicopee						2	2
East Longmeadow					1		1
Holyoke				2	1		3
Longmeadow				1	5	6	12
Southwick				2			2
Springfield				2	3	5	10
Westfield		1			1		2
West Springfield				2			2
Hampshire County							
Granby						1	1
Middlefield					1		1
South Hadley					1		1
Totals	1	6	4	32	42	97	182

Symptoms of the disease include wilting, curling, yellowing, early falling of leaves, and brown streaking of fungus-infected wood. Affected trees die suddenly or gradually. Elm bark beetles serve as carriers of the causal fungus. Adult beetles penetrate between the wood and inner bark of weakened trees and engrave breeding galleries. Later the young emerge to feed on tender small twigs and in so doing may inoculate trees if the fungus was carried from breeding galleries by beetles.

The spread of the disease during the past five years has borne out previous experimental work and observations that the incidence of disease tends to build up where conditions are most favorable for increase in population of carrier beetles. Thus far relatively few valuable elms in Massachusetts have been killed by the disease; but if the spread among weed elms is left unchecked, additional important losses may be expected.

Interest and cooperation in control of the disease throughout the State is encouraging. The timely application of appropriate disease control measures may materially check the spread of the disease.

1. Destroy all elms affected by Dutch elm disease.
2. Remove and burn promptly bark from any cut elm wood.
3. Avoid piling elm wood in the open unless it is peeled.
4. Don't transport elm wood with bark attached.
5. Spray elms to control leaf-eating insects.
6. Keep elms as healthy as possible.

Additional methods of disease control are being explored, and in cooperation with the Department of Entomology the uses of spray materials for control of carrier-insects are under investigation.

Other Tree Problems. Fifty-three diseases of twenty-seven species of trees including nine diseases of elm were identified from approximately 400 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from three additional municipalities in Massachusetts. *Verticillium* sp. was isolated from several species of woody plants.

During the year, postwar planning of municipal tree programs was rapidly accelerated. The most conspicuous and obvious need is treatment of injuries and defects neglected for five years because of man-power shortages. Trees found to be in such condition as to endanger the public should be removed, pruned, or strengthened to eliminate hazards. In many communities a good start has been made on constructive tree protection programs which should help limit the spread of leaf diseases.

The occurrence of broken tree limbs this year has resulted in numerous inquiries. Wind and rain storms have caused considerable damage of this type. Also, in the course of reconverting housing and industrial activities for postwar needs, there has been considerable cartage of relatively large, partly assembled construction units throughout the State. The movement of such material is ordinarily not sufficient to cause extensive breakage of roadside trees. However, currently, extensive tree breakage is traceable to this source as well as to the increasing movement of heavy road-construction machinery along highways.

Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) It was found that, in the absence of fungicides, damping-off is much less severe if soils having a moisture content of about 30 percent of the water-holding capacity at the time of seeding are not watered for the first time until four or five days thereafter.[1]

The use of fertilizers as carriers of soil fungicides, especially for the control of damping-off, cabbage club-root, and soil-borne onion diseases, was further investigated. Organic fungicides used in this or the following project, and hereafter referred to by the trade names only, include tetramethyl-thiuram-disulfide (Arasan, Thiosan, and Tuads); 2, 3-dichloro-1, 4-naphthoquinone (Phygon); tetrachloro-parabenzoquinone (Spergon); disodium ethylene bisdithiocarbamate (Dithane D 14); ferric dimethyldithiocarbamate (Fermate); hydroxymercurichlorophenol (Semesan); and zinc salt of 2, 4-trichlorophenol (Dow Seed Protectant No. 9.)

Mercury salts, 0.2 gm. per square foot, applied to soil in the fertilizer, a 5-8-7 formula, did not control club-root of cabbage in the soils used as well as did hydrated lime. Best results on the basis of disease control and growth of plants were secured with pyridylmercurichloride or ethyl mercury phosphate used in a limed soil.

[1]The writer read a paper on "Control of Damping-off by a Delay in First Watering after Seeding" at the December 1945 meeting of the American Phytopathological Society. An abstract will appear in an early number of Phytopathology.

Fermate, applied to the soil in and with fertilizer, successfully controlled onion smut.[2]

More recent work with onions has involved principally a study of the prevention of pink root-rot of onion, caused by Fusarium, by treatments of soil or sets with fungicides. Yields of onions, from seed, in pink root-rot infested soil were increased 48.9 percent by Thiosan, 70 pounds per acre; 36.9 percent by Fermate, 70 pounds per acre; and 23.3 percent by Fermate, 50 pounds per acre. Treatments of onion sets with Arasan, Fermate, or Spergon failed to lessen the severity of pink root-rot.

Dithane 2.5 cc., Tuads 0.6 gm., or Phygon 0.45 gm. (per square foot in all cases), applied in fertilizer to soil infested with Pythium, markedly improved the stands of onion, cabbage, tomato, and beet, and there was no chemical injury when seeds were sown immediately after soil treatment. Similarly used, Tuads also gave good results with pepper, Phygon with pea, Dithane with cress, and Dow Seed Protectant No. 9 (0.45 gm. per square foot) with cabbage, beet, and cucumber. The last named fungicide, however, was injurious to pea, onion, pepper, and tomato in some soils. The use of fertilizer as a carrier for a soil fungicide is simple and appears promising; and it should be noted that applications of 0.6 or 0.45 gm. per square foot are only about 57.6 or 43.2 pounds per acre.

Seed treatments and several standard soil treatments for the control of preemergence damping-off of *Lilium regale* were compared. The disease was best controlled by seed treatment with Thiosan, Arasan, or Semesan. Spergon or Fermate similarly used gave inferior results and so did the several soil treatments.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L. Doran.) The hemlock, *Tsuga canadensis* (L.) Carr., is highly variable and there are indications of increasing demand for some of the better clones, a demand which will exceed the present supply. Work on their vegetative propagation was accordingly begun. Different clones were found to respond very differently to the same treatments, rooting of cuttings from some, not from others, being improved by treatment with indolebutyric acid 200 mg./l., 8 hours, or 100 mg./l., 6 hr., with powder dips less effective. Rooting of cuttings of hemlock, taken in October and November, was not improved by supplementary treatment with the fungicide Arasan[1] applied after treatment of the cuttings with a root-inducing substance.

The effects of root-inducing substances and fungicides applied together to the cuttings of several conifers and of American holly was also investigated. Cuttings of holly rooted in larger percentages after treatment with indolebutyric acid alone (100 mg./l., 20 hours) than they did if that treatment was followed by treatment with Fermate or Spergon.

A root-inducing treatment which was applied with benefit to cuttings of holly taken in October was apparently injurious to cuttings taken in January.

As a carrier of indolebutyric acid applied as a powder-dip, Spergon caused some injury to cuttings of Norway spruce, but Fermate or Arasan caused no injury.

Rooting of cuttings of hemlock, American arbor-vitae, and Chinese juniper was improved by treatment with indolebutyric acid 4 or 8 mg./gm. Fermate.

Some work was done on vegetative propagation of the Kudzu vine, *Pueraria Thunbergiana* (Sieb. and Zucc.) Benth., interest in which, both as a forage crop

[2]The abstract of a paper by W. L. Doran and T. Sproston, Jr., on "The Control of Onion Smut by Fungicides Applied to the Soil" was published in Phytopathology 35:8:654. 1945.

[1]The active ingredients of this and the other fungicides mentioned are named in the report on the preceding project.

and for soil conservation, is increasing. One-node cuttings responded well to powder-dip treatment with indolebutyric acid, but many cuttings died after rooting if taken as late as September.

In work with the Department of Pomology on the propagation of apple dwarfing stocks, cuttings of Malling No. 4 rooted well if taken in early May and given powder-dip treatment with indolebutyric acid.

Observations on the subsequent growth of rooted cuttings of white pine were continued in the field. They appear to be developing into normal, well-formed young trees.[2]

Surface watering was compared with subirrigation as factors affecting rooting of cuttings of conifers. Cuttings of hemlock, Hinoki cypress, two species of fir, and two species of spruce taken in November rooted better in sand watered from above than in sand subirrigated.

Work on the propagation of the rose by cuttings, initiated at the request of florists who could not obtain grafting stock, was concluded and results published.[3]

Tomato Leaf Mold Caused by the Fungus, Cladosporium fulvum Cke. (E. F. Guba, Waltham.) Four tomatoes resistant to leaf mold were developed to desirable commercial type and released for commercial trial for the fall growing season of 1945. These types were designated Improved Bay State, Improved Vetomold-121, Leafmold Resistant Marglobe, and Leaf Mold Resistant Waltham Forcing. Resistance to the fungus was derived from Plant Introduction No. 112,215, a *Pimpinellifolium* type from Educador. These tomatoes are considered acceptable by the growers. The resistant Marglobe cross is particularly promising.

Four similar tomatoes which derived their resistance from Plant Introduction No. 129,882 from Peru are now completely susceptible to the disease. Other named varieties developed for resistance have also acquired complete susceptibility; namely, Globelle, Veteomold, Vetomold-121, and Bay State.

Varieties introduced to the trade as resistant, apparently have but a limited period of utility before the advantage of resistance is completely lost. Apparently, this is due to the increase in the virulence of the fungus during its culture on successive generations of resistant hosts. Loss of resistance is anticipated in the types derived from Plant Introduction 112,215, and newly released to growers for trial.

The cross of Prince Borghese, an Italian esculentum paste type, with *L. peruvianum* outcrossed to Pan America (No. 44 B 292), and of the same cross backcrossed to Prince Borghese (No. 44 B 293) by W. S. Porte, United States Department of Agriculture, are now the subject of study. *L. peruvianum* is highly resistant to *Cladosporium fulvum* (Mass. Agr. Expt. Sta. Bul. 393:7, 1942). *L. peruvianum* and the wide range of phenotypes in the above crosses are also being studied for their reaction to the rootknot nematode.

Causes and Control of Decay of Squash in Storage. (E. F. Guba, Waltham.) Six plots of squash were grown, each of the same number of plants and identical areas of land. These plots yielded 3871, 3628, 3844, 4935, 3676, and 2742 pounds of squash, respectively.

Hubbard and Butternut squash from plots sprayed five times with Bordeaux 4-4-50 combined with 1 pound calcium arsenate were practically disease-free at harvest, in contrast to the squash from plots not sprayed with fungicide, which

[2]A manuscript on "The Vegetative Propagation of White Pine" has been prepared for publication.

[3]A paper, "Propagation of the Briarcliff Rose by Cuttings" by W. L. Doran, was published in Florists' Exchange 105:11:7, 21. 1945.

showed considerable *Mycosphaerella*, *Choanephora*, and *Alternaria* rots at harvest. The squash from the sprayed plots showed the least amount of decay in storage September 25, 1945–January 2, 1946). The sprayed plots ranked fifth in yield.

There was no difference in amount of decay between long and short stemmed squash from unsprayed field plots.

Dipping Hubbard squash in wax-water-formaldehyde emulsion[1] after harvest did not control decay and did not prevent shrinkage from transpiration. The same treatment of Butternut squash reduced shrinkage considerably but had no effect on the control of decay.

Detail drawings of the fungi of squash decay and photographs of the various kinds of decay have been prepared.

Interrelation of Wettable Sulfur, Lead Arsenate, and Lime in Apple Spraying. (E. F. Guba, Waltham.) Studies were handicapped by the lack of fruit due to freezing and unseasonal temperatures during and subsequent to the blossoming period.

Several fungicides were compared for their eradicant effect on foliage scab. Fermate 1½ pounds, Puratized N 5 E 6 1/3 liquid ounces, and lime sulfur 2 gallons in 100 gallons of water gave the best results, judged by germination studies of the scab spores sampled from the scab lesions at intervals following the treatments. Of these, Puratized gave a superior eradicant effect. The foliage was freed of viable scab spores and the scab mold was removed without any leaf injury. There was no spore germination associated with the Fermate treatment although the spores appeared normal; yet the character of the scab mold on the leaves seemed not to be changed and the amount of scab appeared to increase. The eradicant action of lime sulfur appeared good, yet there was a considerable come-back in spore germination and some burning of the foliage. A second and third treatment gave more complete disinfection of the foliage. The addition of lead arsenate contributed nothing to the eradicant action of lime sulfur.

Analytical studies of sprayed foliage showed greater initial deposits of flotation paste sulfur than of dry wettable sulfur. Weathering action caused more loss of dry wettable than of paste sulfur. Paste sulfur gave the better control of scab.

On the basis of a small tabulation of apples, the period of susceptibility to fruit russet on Baldwin and Delicious apples is believed to occur in the pink, calyx, and first cover stages in tree development. Since none of this injury is caused by a combined spray of Fermate and lead arsenate, it is recommended not to use combined sulfur and lead arsenate until the period designated "second cover."

Resistance to Fusarium dianthi Prill. et Del., the Cause of a Serious Carnation Wilt Disease. (E. F. Guba, Waltham.) From a list of carnation varieties determined to be significantly resistant to *Fusarium dianthi*, the following were retained for breeding purposes and further study.

Dorothy Napier	King Cardinal
Eleanor	Maine Sunshine
Elizabeth Rowe	Miller's Yellow
Georgina	My Love
Hazel Draper	Puritan
Helen Hussey	Tom Knipe
John Briry	Woburn

[1]This wax emulsion disinfectant consisted of 2 quarts formaldehyde, 20 gallons water, and 3 gallons Ceremul wax (Socony Vacuum).

Breeding (selfing and crossing) was handicapped by the failure of some of these varieties to produce pollen and by the production of pollen of others during a limited season. Seed from selfing and crossing has been obtained. More success is anticipated in another season.

Combinations of Fermate and Arasan with hormone powders in the ratio of 10 percent fungicide and 90 percent hormone powder, as a treatment of the basal end of cuttings before they are inserted in the sand, combined disease control with better rooting. Similarly, either Fermate or Arasan combined with talc in a 10-90 ratio gave good control of branch rot and was not harmful to rooting. Comparable results were secured with concentrated Fermate and Arasan. Immersion of the cuttings for 15 minutes in a 1–1,000 solution of potassium permanganate was relatively unsatisfactory. The tests were based on the varieties Eleanor, Olivette, and King Cardinal.

Control of Seed Decay and Damping-off of Vegetable Seedlings with Seed-borne Chemicals. (E. F. Guba, Waltham.) Since the publication of Bulletin 394, "Control of Damping-off of Vegetables by Formaldehyde and Other Chemicals," in June 1942, further seed treatment trials have been made each year. As a result of these studies, Spergon (tetrachloro-parabenzoquinone) is given wider prominence, and Arasan (tetramethyl-thiuram-disulfide) is added and recommended for most vegetable seeds except crucifers. The chemical 2, 3-dichloro-1, 4-napthoquinone (Phygon) is another valuable addition. Revisions in seed treatment recommendations have been made, based on these studies.

Tobacco Frenching Induced by High Soil Temperature. (L. H. Jones.) After Havana Seed tobacco plants had become established in vigorous growth at a soil temperature of 70° F., the soil temperature was raised to 95° in one half the series, while the other half was left at 70° as a check. Frenching eventually developed in all the plants at the high temperature and the check plants remained normal.

The fact that the plant containers used in previous experiments were of galvanized iron suggested the possibility of toxicity from zinc compounds made soluble by a high moist temperature in the presence of soil constituents. To eliminate this possibility, one-gallon glazed crocks were set into the two-gallon galvanized iron containers. Lime in the form of calcium hydroxide and boron in the form of borax were added to a portion of the series. The frenching symptoms appeared in all plants at 95° F. soil temperature and were absent at 70° F. regardless of other treatment. Prior to the appearance of extreme symptoms of frenching, leaves intermediate in development between normal and truly frenched exhibited an interveinal chlorosis best described as pinhead mottling. Whenever this occurred, terminal growth decreased and the tip of the plant gradually developed a rosette of typically frenched leaves. There was considerable time lag between exposure to the high soil temperature and appearance of the pinhead mottling. Plants in the glazed containers were the first to show the symptoms, 21 days being the minimum time and this in the months of February and March. Limed soil produced the largest plants and delayed the appearance of the symptoms, the time lag being 35 days. Borax delayed the appearance of symptoms still longer, 57 days, but did not reduce their severity. The cessation of terminal growth as one of the symptoms of frenching sometimes released the inhibitory influence in the development of buds in the axils of the leaves. When growth in the axils did occur on frenching plants, it was either an elongating axillary shoot with frenched leaves. eventually producing a rosette comparable to that on the original terminal shoot, or simply a rosette of frenched leaves in the axil. The elongating shoots were nearer the tip of the plant and the suppressed shoots were nearer the base.

After the experiment had been running 80 days, all the plants were topped below the terminal growing point, and half the plants which had been at 95° F. soil temperature were exchanged with plants which had been at 70°. The shift was made in April when the daylight period is longer than in February when the experiments were started. The time lag before frenching symptoms appeared in the plants shifted to the high temperature was shortened, possibly because of better growing conditions. The minimum time before the appearance of the pinhead mottling which preceded the development of frenched leaves was reduced from 21 to 14 days. The same pattern of frenching symptoms was in evidence. Axil shoots which developed on plants shifted to 95° soil temperature had a carry-over of the normal characters of the 70° soil temperature, but eventually leaves developed with the frenching characters. Plants which had been shifted from 95° to 70° soil temperature also had a carry-over which expressed itself in some cases on the axillary shoots that developed just below the decapitated terminal. These shoots showed intense frenching on the lower leaf, but each succeeding leaf was less frenched until an apparently normal leaf was finally produced. There were instances where young leaves, decidedly frenched, began to grow again when shifted to the lower temperature and became wider with less waved margins, but they never developed into leaves of normal shape. On the other hand, no leaves of normal shape developed frenching symptoms when shifted from the low to the high soil temperature.

These results suggest that soil temperature may play a regulatory role in the frenching of tobacco by affecting absorption or translocation of nutrient elements and may even affect metabolic activity to the extent of creating growth-controlling substances either by synthesis or as by-products of a breakdown of chemical compounds within the plant.

Toxic Effect of Wood Preservatives on Plants. (L. H. Jones.) In previous work with lumber impregnated with asphalt, injury to seedling plants was traced to a small quantity of creosote which had not been removed from the resins. It has now been demonstrated that when the creosote is entirely removed there is no injury to plants from such treated wood.

It is generally understood that the greatest damage done to green leaves by creosote fumes is by the toxic action of the gas entering the leaf through the stomata. It now appears that damage may be caused also by the dissolution of the leaf, which exposes the tender cells to the dehydrating effect of dry air. Further investigation will be necessary to confirm this type of injury.

DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

Factors Affecting the Vitamin Content of Milk and Milk Products. (Arthur D. Holmes.) The investigations that have been conducted under this project during the past year, involve consideration of several factors, but the published papers dealt with two topics: the food value of ice cream as a source of common vitamins, and the vitamin content of mare's milk.

Ice Cream As a Source of Riboflavin, Carotene, and Ascorbic Acid. (Arthur D. Holmes, John W. Kuzmeski, Carleton P. Jones, and Frank T. Canavan.) Coffee, maple, and vanilla ice creams were manufactured on the commercial scale in the Dairy Laboratory from 24.4 pounds of cream (40 percent), 56.3 pounds of whole milk, 15.0 pounds of cane sugar, 4.0 pounds of skimmed milk powder, and 0.3 pound of gelatin. The overrun was 85 percent; i.e., 9.25 pounds per gallon of the ice cream mixture weighed 5 pounds per gallon when frozen. Ten samples

of each flavor of ice cream were assayed. The carotene content was 0.10 mg. per 100 gm.; the riboflavin, 0.26 mg. per 100 gm. No reduced ascorbic acid could be detected in any samples, probably owing to destruction by the large amount of air incorporated in commercial ice cream to increase its bulk. Comparison of these ice creams with numerous widely used foods, showed them to be excellent sources of carotene and riboflavin. Since the average yearly consumption of ice cream is estimated at three gallons per person, it contributes significant amounts of carotene and riboflavin to the human dietary.

The Vitamin Content of Mare's Milk. (Arthur D. Holmes, Beula V. McKey, Anne W. Wertz, Harry G. Lindquist, and Leonard R. Parkinson.) This investigation was undertaken to compare the composition of cow's milk and mare's milk—two species of animals that consume the same type of ration, but possess different types of digestive tracts. Studies have shown that the vitamin content of cow's milk is likely to be due in part to vitamins produced by bacterial synthesis in the cow's rumen, but the mare has no rumen. This, the initial paper of a proposed series, reports the results of assays of mare's milk for ascorbic and nicotinic acids, riboflavin, thiamine, bacteria, fat, size of fat globules, and total solids. Three normal, adult Percheron brood mares, in the latter stages of lactation, were used as a source of the milk. Eleven samples of fore-milk were obtained from each mare in the early morning. The average values obtained were: ascorbic acid, 12.9 mg.; nicotinic acid, 0.72 mg.; pantothenic acid (3 samples,) 2.77 mg.; riboflavin, 0.11 mg.; thiamine, 0.39 mg. per liter; bacteria, 3.70 per cc.; fat, 1.2 percent; fat globule size, 3.4 microns; and total solids, 10.20 percent. The values for ascorbic acid, nicotinic acid, riboflavin, fat, and total solids were lower than the corresponding values for milk from cows that consumed the same pasturage; but the thiamine values were higher. The greatest difference in vitamin content between mare's and cow's milk was in riboflavin. As yet, it is impossible to explain why the former has much less than one tenth as much riboflavin as the latter.

A Study of the Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption. (Arthur D. Holmes and Carleton P. Jones.) During the past year published results from the studies in this field have been concerned with kale and summer squashes grown under local climatic and cultural conditions, and supply information of particular value regarding the value of these vegetables for the human diet.

Influence of Supplementary Calcium and Magnesium Fertilizers Upon Nutritive Value of Kale. (Arthur D. Holmes, Leo V. Crowley, and John W. Kuzmeski.) The kale was grown on a Merrimac fine sandy loam in four experimental plots, all of which received a commercial 4-9-7 fertilizer at the rate of one ton per acre. In addition, the experimental plots received varying amounts of magnesium sulfate, ground limestone, or both, with one plot serving as a control. Twenty samples of kale were assayed for water, calcium, iron, magnesium, phosphorus, and carotene. The addition of 150 pounds of magnesium sulfate per acre definitely increased the magnesium content of the kale and may have slightly increased the calcium and phosphorus content. Limestone, applied at the rate of 1,000 pounds per acre, definitely increased the calcium and phosphorus content of the kale and may have depressed its iron content. Neither magnesium sulfate nor limestone nor both produced any pronounced effect on the water or the carotene content of the kale. As compared with other leafy vegetables kale is rich in carotene, the precursor of vitamin A. Judged by the results of this study, the use of magnesium sulfate and limestone as supplementary fertilizers enhances the food value of kale.

Ascorbic Acid, Carotene, Chlorophyll, Riboflavin, and Water Content of Summer Squashes. (Arthur D. Holmes, Albert F. Spelman, and Carleton P. Jones.) Seven varieties of this vegetable were studied. Five were *Cucurbita pepo* L. and two were *Cucurbita moschata* L. The ascorbic acid content of the raw squashes varied from 4.2 mg. for Cocozella to 16.7 mg. per 100 gm. for Early White Bush Scallop. Four varieties—Early Summer Crookneck, Early Summer Prolific Straightneck, Golden Cushaw, and Early White Bush Scallop—contained over half as much ascorbic acid as milk, decidedly over half as much as summer tomatoes, and from 50 to 100 percent more than late-winter tomatoes. The carotene content varied from 0.06 mg. for Early White Bush Scallop to 6.21 mg. per 100 gm. for Golden Cushaw. Two varieties, Butternut and Golden Cushaw, were extremely rich in carotene. The chlorophyll content varied from 0.42 mg. for Early Summer Prolific Straightneck to 12.25 mg. per 100 gm. for Zucchini Grey. The two squashes with green-colored skins, Cocozella and Zucchini, contained large amounts of chlorophyll. The raw squashes were rich sources of riboflavin. The Early White Bush Scallop contained about 33 percent, Butternut about 49 percent, Early Summer Crookneck about 79 percent, Cocozella more than 115 percent, and Golden Cushaw about 166 percent as much riboflavin as milk produced in this locality.

Vitamin Content of Field-Frozen Kale. (Arthur D. Holmes, Beula V. McKey, Katherine O. Esselen, Leo V. Crowley, and Carleton P. Jones.) It is generally agreed that the leafy green vegetables are extremely valuable components of the human diet. Unfortunately, nearly all the green vegetables are seriously damaged, if not destroyed, by freezing temperatures. Following the first killing frost, there is a considerable period during which plants that escape the frost thrive, and kale is one of these. Because of the scarcity of fresh green leafy vegetables in gardens in this area during the late fall, it seemed desirable to determine the vitamin content of field-frozen kale. Dwarf Blue-Green Scotch kale that had been subjected to freezing seven times during the previous month, was collected for assay. Eighteen samples were examined. Very mature and immature leaves were analyzed, with the following results:

	Mg. per 100 gm.	
	Very Mature Leaves	Immature Leaves
Ascorbic acid	158.6	212.2
Carotene	6.3	5.6
Nicotinic acid	1.94	2.21
Pantothenic acid	0.73	0.91

These figures supply evidence that field-frozen kale can contribute essential nutrients for the human diet, especially when the supply of fresh green leafy vegetables grown in this area is limited.

Physico-Chemical Properties of Starch. (Monroe E. Freeman.) The abnormal specific heats found previously for starch suspensions may be explained by the presence of a loosely bound shell of absorbed water on the starch grains. The quantitative data follow mathematical equations relating the composition of the sample, the heat of desorption, the amount of loosely bound water, and the maximum hydration capacity. The identical behavior of gum arabic, lemon pectin, egg albumin, and gelatin verifies this explanation. Cellulose, agar agar, and sodium bentonite systems apparently do not have this loosely bound fraction. This seems to be a general characteristic of hydrophillic colloids that has not been previously demonstrated.

The quantitative evaluation of this factor affords, for the first time, an accurate measurement of the specific heat of starch suspensions and permits the measurement of the heat of gelatinization. Preliminary experiments have indicated that this may be much lower than previously reported in the literature and may even be non-existent. Further experiments now in progress are expected to throw some light on the mechanism of starch gelatinization.

The Chemical Investigations of Hemicelluloses. (Emmett Bennett.) During the past year some of the data reported previously have been checked and certain difficulties encountered have been eliminated. The acetylation procedure generally used in this investigation would not produce the diacetate of xylan in the hemicellulose from rye straw. It was necessary to hydrate this material and to dehydrate it without exposure to air just prior to acetylation. In this way, the theoretical acetyl content could be obtained almost completely.

Results obtained so far in this investigation would seem to indicate that anhydroxylose and a hexuronic acid anhydride account for approximately 85 and 90 percent of the hemicelluloses of maize cobs and rye straw respectively. The proportions of these two constituents would correspond to a chain of anhydroxylose units approximately 30–32 units in length and terminating in a hexuronic acid group. The sugars seem to have the pyranose structure and to be connected to each other through a beta-linkage. A hexose was present to a slight extent in both hemicelluloses, while l-arabinose was detected in maize cob hemicellulose only.[1]

Studies on the Quantitative Estimation of Hemicelluloses. (Emmett Bennett.) The success of the method being tested for the quantitative determination of hemicelluloses depends upon the production of a holocellulose which contains all the hemicellulose. The percentage recovery of furfural and the color of the holocellulose were used as an index for the preparation of a holocellulose fraction which would be suitable for the quantitative extraction of hemicelluloses. A procedure suitable for the determination of this fraction in non-woody plants has been standardized. Furfural determinations on holocellulose from five different plants indicate that from 95 to 99 percent of the furfural in the original tissue can be recovered.

Nitrogenous residues seem to be the chief contaminants of holocellulose prepared from cereal grasses. In some cases 50 percent of the total nitrogen may be retained.

Preliminary extractions of hemicelluloses from holocellulose with 1.25 percent sodium hydroxide and the aid of a Waring blendor for periods of different length, yield the same results. This is believed to be indicative of a complete extraction of the more loosely bound hemicelluloses, since the residual material still bears compounds which will yield furfural.

Extracts were oxidized under definite conditions by means of a solution of hot chromic acid. The amount of material oxidized was determined colorimetrically by means of a spectrophotometer. Calibration lines were constructed from data obtained by oxidizing pure solutions of glucose and xylose under definite conditions. From such lines and the percentage transmission of an unknown solution, the percentage concentration can be determined as xylose or glucose.

The Investigation of Agricultural Waste Products. — 1. The Chemical Investigation of Lignin. (Emmett Bennett.) The results of the study of the effects of large quantities of pure lignin upon the aerobic decomposition of plant materials appear in the forthcoming volume of the Proceedings of the American Society for Horticultural Science.

[1]The results have been accepted for publication by the Journal of Agricultural Research.

The present line of investigation deals with the oxidation of lignin by nitric acid and by reagents in which the cation changes valence such as ceric sulfate. No comments are warranted at this time.

CONTROL SERVICES

Philip H. Smith in Charge

The fertilizer, feed, seed, and milk testing laws are administered as one service and the operations of each of these, with the exception of the milk testing law, are reported in annual bulletins issued for that purpose.

Under the milk testing law 5,623 pieces of Babcock glassware were tested for accuracy and 107 certificates of proficiency in testing were issued. In addition, all milk depots and milk laboratories in the State, of which there are 192, were visited at least once, as required by statute, in order to check apparatus and the general conduct of the work. It can be assumed that the greater part of the milk sold in Massachusetts is now paid for on the basis of weight and test rather than by the quart.

Under the fertilizer act the number of brands registered was about the same as for 1945; 258 in 1945 and 260 in 1946. This in spite of Federal regulations and the effort of agronomists to reduce the number of grades manufactured. The number of samples collected and analyzed has been less than for normal years but it is believed that the samples collected fully represent the grades offered in Massachusetts. Deficiencies (variations from guarantee) have not been so extensive as in previous years.

While the tonnage of feed sold in Massachusetts has been reduced because of shortages, many brands have been found that have not been previously offered for sale within the State. This has been due in large measure to the inability of many feed manufacturers to fill the requirements of their customers, who have therefore been obliged to look to smaller mills in the Middle West.

The work of the seed laboratory has continued to grow, largely on account of the realization on the part of seed dealers of the prime importance of good seed if good crops are to be expected. Through the Federal Seed Act, where seeds have entered into interstate commerce, the laboratory has been able, through cooperation of the Federal officials, to cause the prosecution of flagrant violations. This as a Federal and not as a State matter.

Considerable time has been devoted to assays and analyses not directly connected with the Control Acts but for which there appears to be a need. With increasing knowledge of the role of trace elements in plant and animal nutrition, the fertilizer and feeding stuffs laws should be made more comprehensive so as to include such elements where their presence is indicated as a part of the guarantee. Such legislation should also include vitamins where their presence is claimed.

As in the past, the Control laboratories have examined fertilizers, feeding stuffs, and other material for citizens of the State without charge wherever the work could be considered of general public value. More than the usual number of samples of feed were received which the feeders claimed to have caused the death of poultry. With few exceptions the contention could not be proved by any analysis to which the feed was subjected.

In addition to regular routine duties Control Service has been called upon to the extent of time available to assist other departments of the College and Station in conducting work in connection with research problems not originating in the department itself.

THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

DDT. This insecticide was advocated as a control for gypsy moth caterpillars in the annual Cranberry Insect and Disease Control Chart in the spring of 1946, and it was used widely and freely both on bogs and on the surrounding uplands, especially in Plymouth County, with entirely satisfactory results. In spraying, complete kills were obtained with 2 pounds of the 50 percent wettable powder in 100 gallons of water, 400 gallons to an acre; and with 3 pounds in 100 gallons, 250 gallons per acre. In dusting, 50 pounds of the 5 percent dust to the acre was used. No injury to cranberry vines from the DDT appeared.

DDT was used considerably as a spray and as a dust treatment for the first brood of the black-headed fireworm in May and early June, 1946, in the amounts found effective against gypsy moth caterpillars, and the control appeared to be satisfactory in all cases. Its further use against first-brood fireworms seems advisable. It probably should not be used on second-brood fireworms or on blunt-nosed leafhoppers till more is known about its effects on bees.

Fireworm Flooding. Flooding for as short a period as 10 hours to kill the less-than-one-third-grown black-headed fireworms of the first brood was tried very successfully in 1945 and was advocated in the 1946 Cranberry Insect and Disease Control Chart. Various cranberry growers tried this treatment in the spring of 1946, some of them with excellent results. It was found that, to be entirely successful, it has to be repeated once or twice at intervals of a week to 10 days. The success of this treatment seems to be based on the following facts:

(a) It is especially important to kill the leaders of the first brood of worms, for their moths lay most of the eggs which produce the second-brood worms of this only partially two-brooded insect.

(b) A short flooding kills the smaller worms more easily and completely than the larger ones.

(c) Short floodings are less likely to harm cranberry vines than the longer ones heretofore employed.

Dusting by Airplane. Extensive tests of dusting by airplane were conducted by the A. D. Makepeace Company in the spring of 1946. Observations of the results indicated that this method of treatment is practicable on cranberry bogs when properly applied. It probably will come to be used widely in treating the gypsy moth and the black-headed fireworm.

Prevalence of Cranberry Insects in the season of 1945:

1. Gypsy moth infestation moderate, but heavy in some sections.
2. Leafhoppers (*Ophiola*) not very plentiful.
3. Fruit worm infestation lighter than for many years, in very striking contrast to the severe infestation of 1944.
4. Black-headed fireworm less troublesome than usual.
5. Practically no fire beetles (*Cryptocephalus*) found.
6. Very few spotted fireworms (*Cacoecia*) found.
7. Ladybugs normally abundant.
8. Spanworms in general not troublesome.
9. False armyworm (*Xylena*) infestation normal.
10. Black cutworm (*Euxoa*) infestation medium, mostly on bogs flowed for control of root grub (*Amphicoma*).

11. The armyworm (*Cirphis*) broke out on a good many bogs from which the winter water was let off late. They appeared in some cases where the water was let off as early as May 20. This was very unusual and may have been due to the very warm weather in March and April.

12. Cranberry girdler (*Crambus*): General infestations by this insect on the Cape Cod cranberry bogs were more severe than for many years, this evidently being due largely to lack of sanding because of labor shortages and to lack of dusting because of the shortage of Pyrethrum.

13. Spittle insect, cranberry weevil, and tipworm infestations about normal.

14. Bumblebees and honeybees less abundant than usual. Scarce on many bogs.

Weather Studies. (H. J. Franklin.) A project entitled "The Relationship of Weather to Cranberry Production through its Various Effects on Photosynthesis and Growth," established in December 1935, was brought to a close in May 1946, and the results were presented for publication as a bulletin of the Station.

Frost forecasts were continued as a special service, 212 cranberry growers subscribing to the telephone service. The forecasts by radio were cooperative between the United States Weather Bureau office at Logan Airport and the Cranberry Station at East Wareham and were distributed by stations WEEI at Boston and WOCB at West Yarmouth.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

New Sterilizing Agents for Dairy Use. (W. S. Mueller, E. Bennett, and J. E. Fuller.) The germicidal properties of the following surface-active agents have been investigated further: 9 quaternary ammonium compounds, 3 phosphonium compounds, 3 substituted phenols, 10 alkyl aryl sulfonates, 1 aryl alkyl polyether sulfonate, 1 aliphatic sulfonate, 1 aryl alkyl polyether alcohol, 2 polyoxyalkylene of fatty acids, 1 aliphatic sulfate, 1aryl alkyl polyether sulfate, 4 monoesters of polyhydroxy compounds, and 6 unknowns. Other properties which were investigated are stability, corrosiveness to metals, solubility, odor, taste, and color. Germicidal tests made within one year after the surface-active agents were obtained showed that 9 were effective sterliizing agents, 9 were moderately effective, and 24 were ineffective. The effective group included only quaternary ammonium and phosphonium compounds; while the moderately effective group included substituted phenols, alkyl aryl sulfonates, and aliphatic sulfonates. One or more of the materials of each class were represented in the ineffective group, with the exception of phosphonium compounds, substituted phenols, and aliphatic sulfonates. After 2½ years of storage only the quaternary ammonium and phosphonium compounds retained their effective germicidal properties, while all of the materials which were found to be moderately effective at first had lost most of their germicidal properties during storage. No correlation was noted between pH values, germicidal property, and stability of the products. The quaternary ammonium compounds were readily soluble, were not objectionably corrosive to metals, and were practically odorless, tasteless, and colorless, all of which are desirable properties of a dairy sterilizing agent. While the phosphonium compounds also were non-corrosive to metals and had no serious objectionable odor and taste, they did not go into solution readily and produced cloudy solutions. Results to date indicate that only the quaternary ammonium

compounds show more than ordinary promise as a superior sterilizing agent for dairy use. A paper on this study has been submitted for publication.

Effect of Certain Antioxidants on the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller.) Further studies have been made on the antioxidative properties of cacao-shell and cocoa powder and certain extracts of these products, by noting their effect in butter oil, with and without added copper. Two accelerated tests, the Modified Schaal Test and the Swift Fat Stability Test, were used and the following determinations were made: Peroxide value, color (indirectly vitamin A), taste, and odor. The cacao antioxidant was more effective for butter oil in the presence of copper than in the absence of the metal, and was a potent inhibitor of the pro-oxidant effect of copper. The natural inhibitors of cacao-shell and cocoa powder were successfully extracted with suitable solvents. Drying the extracts to a powder did not significantly decrease their protective properties. The cacao inhibitor was found to be more potent than the natural inhibitors of wheat germ and of oat flour. A cacao-tannin was isolated from cacao shell and was found to be less potent as an inhibitor than pure tannic acid.

Study of Packaged Ice Cream. (J. H. Frandsen.) During the year further studies have been made in comparing the palatability of packaged and bulk ice cream under factory, drugstore, and ice cream retail store dipping conditions. Results of studies here and conferences with men in plants indicate that, under ideal conditions and with trained personnel, losses in dipping bulk ice cream may be reduced to from 20 to 30 percent. However, under ordinary conditions and with unskilled scoopers, there is a loss of from 30 to 40 percent in volume from packaging bulk ice cream as compared with the same ice cream machine-packaged directly from the freezer.

Our research work would indicate that if packaged ice cream is made from mix of the same composition as bulk ice cream, and if the overrun of the packaged ice cream is reduced 15 percent from that of bulk ice cream, the resultant ice cream should be fully as palatable and nutritious as bulk ice cream. This should overcome the prejudice now existing against packaged ice cream. The trend is towards packaged products, and packaged ice cream is in line with this trend. Machine-packaged ice cream can be kept at a lower temperature than bulk ice cream and therefore should reach the home of the cash and carry consumer in a more satisfactory condition than the warmer hand-packaged bulk ice cream.

DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

Effects of the War and Readjustments in Massachusetts Agriculture. (David Rozman.) The major phase of the work on this project has been completed and the results presented in Bulletin 430 published under the title, "Postwar Readjustments in Massachusetts Agriculture." Of special significance among the various readjustments emphasized by the results of the study is the reconstruction of land resources in farming areas. Other important facts and recommendations brought out by the study are:

1. More than half of the commercial farming units in Massachusetts fail to meet desirable requirements of income for farm families.

2. The greatest need is for the reconstruction of substandard farming units into efficient, economic family farms capable of providing an adequate level of living under modern conditions.

3. The classification of soil and field investigations carried out in a number of towns indicate that improvement of undeveloped areas, where the cost is justified by resulting benefits, may serve to enlarge and improve land resources on existing farms, to make possible the replacement of poor land now in use, and to provide for new farming units.

4. Improvement in the condition and productivity of pasture and hay lands, the most important assets in Massachusetts agriculture, will reduce costs and improve the position of many Massachusetts farms.

5. Management of farm woodlands, which represent about 37 percent of the total area of Massachusetts farms, should be integrated with other farming operations to secure higher returns to producers.

6. The position of Massachusetts agriculture in the postwar period will be determined by the successful reduction of costs through the adoption of the most efficient methods, whether they are in the use of land resources, the employment of labor, the use of machinery, or the marketing efforts.

Additional material, prepared in connection with agricultural readjustments was presented in a manuscript dealing with the 1946 production program for Massachusetts agriculture.

DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

Cranberry Storage Investigation. (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) Storage investigations on cranberries were continued during the 1945 season. Berries were put in storage on September 7 and removed and screened on November 1. Losses under different conditions of storage were as follows:

	Percentage Loss	
	At Screenhouse Temperature	At 45 degrees
In normal atmosphere	8.4	5.6
In controlled atmosphere:		
11 percent carbon dioxide	12.3	
2.5 percent carbon dioxide		7.4

Berries stored in a carbon dioxide atmosphere, even at the low concentration of 2.5 percent, colored much less than those stored in normal atmosphere. Berries stored at 45 to 50 degrees color much more than those held at lower or higher temperatures, all being stored in normal atmospheres.

Storage of berries in refrigerated rooms at temperatures from 35 to 45 degrees will reduce storage losses considerably below that which occurs in the common screenhouse. Storage in controlled atmosphere holds but little promise of success.

Poultry House Investigation. (C. I. Gunness and W. C. Sanctuary.) In the study of poultry housing, emphasis was placed on method of ventilation and arrangement of equipment to permit the housing of the maximum number of birds in a given pen. The test pen housed 150 birds, allowing 2.66 square feet per bird. This pen would normally house only 100 birds, and this number was housed in the check pen which is equal in size to the test pen. Better use of floor space was obtained in the test pen by raising feed hoppers and watering troughs off the floor. The down-draft baffle ventilator was used in this pen, opened to the extent that ventilation was increased proportionately with the

increase in the number of birds as compared with the check pen. The litter was not changed during the season. At the end of the season the litter in the check pen housing 100 birds had a moisture content of 28 percent. In the test pen housing 150 birds, the moisture content of the litter was 36 percent. Egg production was equal in the two pens, but mortality was slightly higher in the crowded pen.

Electric ventilation was compared to natural ventilation through windows utilizing the down-draft baffle device. The electric fan was installed in a pen at the east end of an uninsulated house, while the check pen was the center pen in a three-pen insulated house. The electric fan was so installed as to circulate 300 cubic feet per minute, discharging through a long duct placed near the floor at the front of the house. The fan sucked in 90 cubic feet of fresh air per minute from the outside. The windows remained closed during the season. Foul air was discharged through an opening in the floor at the east end of the pen. The fan ran continuously and drew 40 watts.

The litter was not kept as dry as in former years, presumably because the pen was more crowded. The pen housed 100 birds, the same as the check pen. At the end of the season the litter contained 51 percent of moisture. Relative humidity in the pen was higher than in the check pen, but very little frost accumulated on the ceiling and temperature was kept higher than would have been possible with window ventilation. Egg production was slightly higher than in the check pen and mortality no higher.

Hay Drying. (C. I. Gunness and J. G. Archibald.) Mow drying of loose hay was continued in one of the college barns. This installation was used to take care of lots of hay which were too wet to put in the barn and which would very likely have been injured by rain if left out another day. The installation seemed very much worth while from this standpoint.

Three installations in the State have been available for study and observation. One, made in 1945 for drying baled hay, has a capacity of 50 tons and was filled three times in 1945 for three cuttings of alfalfa. Some of the bales contained up to 43 percent of moisture and in general came out very well to the satisfaction of the owner. One lot was put in in June of this year. Because of the excellent weather for haying, the bales were not put in as wet as last year, but wet enough so the hay has come out in good condition with excellent color.

Two other installations have been made in which air has been heated by being passed over steam radiators. The advantage of heating the air has been quite apparent, but a full report on this season's operations can not be made at this time.

DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

The early season of 1945 was characterized by very unusual weather conditions. During March there occurred a period of extremely hot weather which stimulated both plant and insect growth. European corn borer development was hastened so that pupation of overwintered larvae began much earlier than usual, and fruit bud development by the end of the month was approximately a month ahead of normal. In April, conditions reverted to ranges more normal for March, culminating in the freeze of April 23 which caused very general and severe damage to fruit buds and destroyed the crop in many orchards. May was cold and wet, conditions which were very unfavorable for activity of European corn borer moths and held the first brood of borers to such a low point that early corn suffered very slight damage whether treated or not.

The outstanding feature of June was excessive rainfall. Rain occurred on 17 days and the total rainfall for the month was 7.67 inches, a record exceeded only three times since the weather station in Amherst was established. One of the most severe hailstorms in recent years occurred on June 15, accompanied by 1.85 inches of rain. Hail knocked down some fruit and severely scarred most of that which remained on the trees. The hail also caused severe breakage of potato plants and the heavy rain washed some areas badly. The plots were flooded for more than 24 hours and neither spraying nor cultivation could be attempted for a week.

July was marked by heavy and frequent rains. The potato plots were again flooded and no spray equipment could be operated through them from July 9 to 23. Following this setback, plants in all but the higher areas began to turn yellow and died prematurely. During this period also, blight began to appear. Hot humid weather further aggravated the situation. Plants in most of the plots never recovered, and yield records could be taken from only small areas of higher elevation in the field.

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued in 1945, both at Amherst and Waltham.

Through the growing season, apple aphids were very scarce and there were practically no leafhoppers. European red mites were not only scarce but practically nonexistent throughout the college orchards and commercial orchards near by. It was not until about early September that there was any evidence of this pest. Then a sudden outbreak occurred in which a moderate to heavy infestation developed and some bronzing occurred. The attack was of comparatively short duration.

The experimental materials, Dinitro compounds D 289, D 389, C 506, and D 524, applied to apples while they were dormant, practically eliminated all aphid infestation, while on unsprayed checks the infestation averaged 720 aphids per 100 buds. None of the materials caused any direct injury to opening buds or retardation in seasonal development.

D-542 Dinitro-ortho-cresol, at both 4 and 5 percent strengths, caused an almost perfect kill of oyster shell scale on lilac.

The outstanding feature of the season's program was the successful control of the blueberry bud mite (*Erophyes vaccinii*) in commercial plantings by the use of Dn-111 in early June. Previous to these tests no spray application had been successful as a control measure. Dn-111, 20 ounces, plus Ultrawet spreader, 8 ounces, per 100 gallons reduced the number of mites per bud on the varieties Pemberton and Wareham from 54 and 59 before spraying to an average of 2.5 mites per bud for the two varieties, within 24 hours. Some injury resulted.

A second series of tests in which Dn was applied at strengths of 16 – 20 ounces per 100 gallons and at 150 pounds pressure instead of 400 pounds as in the first series, gave successful control of the mites in 24 to 48 hours and caused no serious burning. The concentration of the spray seemed to make little difference, but the reduction in pressure appeared to be an important factor in preventing injury.

In a late-season outbreak of European red mite on apples and beach plums, both Dn-111 and D-4 gave 98 to 99 percent control within 24 hours.

Studies of Different Forms of DDT. (A. I. Bourne and W. D. Whitcomb.) Materials tested were supplied by Geigy Company, Inc., and included Gesarol AK-40, Gesarol A-20 (water dispersible powders), and A-5 dust.

Orchard Tests Against Apple Pests.[1] Because of the adverse weather conditions mentioned above, several readjustments had to be made in the plans for the experiment. The set of fruit was light and scattering and much of it was severely damaged by hail. In the face of such handicaps the results of the season's work cannot be given as much weight as could be desired, but some significant differences were noted. Yield records were taken on McIntosh only.

On unsprayed checks, such fruit as survived the frost and hail damage ripened and dropped prematurely. Practically all of it was infested by curculio, codling moth, and apple maggot and blemished by scab.

DDT gave excellent control of codling moth. At a dosage of 1 pound Gesarol AK-40 (0.4 pound DDT) per 100 gallons, only 1.5 percent damage was recorded; and at a dosage of 2 pounds, no injury was found. The standard spray schedule in this block held codling moth damage to 3 percent.

DDT was not as effective against plum curculio as was the standard schedule with lead arsenate, although a combination of lead arsenate and DDT gave somewhat better control than lead arsenate alone.

No evidence of apple maggot damage appeared in any sprayed plot.

DDT on Potatoes. Reports that DDT has proved a good insecticide for potatoes would appear to be borne out in the 1945 tests. A spray contining 0.4 pound DDT (1 pound Gesarol AK-40) per 100 gallons combined with a 10–5–100 homemade Bordeaux mixture was used in the test plot. No aphid infestation developed in this plot during the season. There was a very conspicuous reduction in flea beetle damage in the DDT plot, and the highest yield of any of the plots (273 bushels per acre compared with 261 following standard 10–10–100 Bordeaux mixture with calcium arsenate). The vines in the DDT sprayed plot showed consistently more vigorous growth and remained green for a longer period than in any other plot.

The results of these tests in a season of very unfavorable weather conditions, correspond closely with those reported elsewhere. It can be expected that DDT will become an important element in the spray program for potato pests.

DDT on Onions. DDT spray at 0.4 pound DDT (2 pounds Gesarol A-20) per 100 gallons gave 89 percent control of onion thrips, as compared with 90 percent following application of a 4 percent derris powder (4 pounds per 100 gallons) and 91 percent following a fixed nicotine spray (3 pounds per 100 gallons). A 5 percent DDT dust gave 90 percent control compared with 81 percent following a 1 percent rotenone dust.

In a second series, heavy rain a few hours after application appeared to cut down the efficiency of most of the materials. DDT spray gave 82 percent control; derries 83 percent; and fixed nicotine, 80 percent. DDT dust gave 70+ percent control; rotenone dust, 61 percent. These results indicate that DDT was affected much less by rain soon after application than were the other materials.

Records of treated plots four days after treatment showed that DDT spray was giving 85 percent control, derris 38 percent, and fixed nicotine 71 percent. DDT dust showed 98 percent control; rotenone dust, 24 percent. Apparently DDT had a considerable residual effect.

In a third series, the Rohm & Haas wetting agent, Triton X-100, 6 fluid ounces to 100 gallons, was used with all spray materials and made a vast improvement in application and resultant effectiveness. DDT gave 99+ percent control, and derris 98.8 percent, in comparison with unsprayed checks. DDT dust gave 93 percent control.

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[1] Further details of these tests will be found under the project "The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts."

Rose Chafer. In two series of laboratory tests against the rose chafer, DDT spray at dosage of 0.4 and 0.8 pound DDT (Gesarol AK-40) and a 5 percent DDT dust proved very effective. Within one-half hour beetles began to show poor coordination, and became more and more inactive and helpless. After 5 to 6 hours practically all beetles were quite inactive and in about two days all died. There was practically no evidence of feeding or other normal activity after treatment.

Gypsy Moth. In three series of tests, one-half to three-fourths grown larvae soon began to show ill effects, poor coordination of muscles gradually increasing to inactivity. Within two to three days practically all had died. Full-grown larvae succumbed somewhat more slowly and in few cases attempted to form pupae. There was very little or no evidence of feeding after treatment.

A young planting of one-year-old apples, which showed an average infestation of about three half-grown larvae per tree and considerable foliage injury before treatment, was cleared of the infestation with one application. Half the block was sprayed with 0.8 pound DDT (2 pounds Gesarol AK-40) per 100 gallons, combined with a wettable sulfur fungicide. The rest of the block was sprayed with lead arsenate, 5 pounds to 100 gallons, plus wettable sulfur and excess lime. Examination five days after treatment showed no larvae on DDT rows, but one larva following arsenical spray.

Tarnished Plant Bug on Potatoes. A commercial planting of potatoes was attacked by tarnished plant bugs migrating from a recently cut field of clover and swarming over the plants of several rows of potatoes. Almost every growing tip was attacked and many were killed. One spray application of DDT, 0.5 pound per 100 gallons, cleared the field of bugs in about three days, and subsequent application to potatoes and an adjoining strip of clover stubble prevented further migration. The plants recovered and yielded an excellent harvest.

European Corn Borer. The infestation throughout the State was very light in 1945, particularly in the Connecticut Valley region. This was due in large part to adverse weather conditions during the period when moths were present. Emergence was prolonged, moth activity was seriously reduced by cold, wet weather, and egg laying was very slight and irregular.

A spray containing 2 pounds Gesarol A-20 (0.4 pound DDT) per 100 gallons, plus Ultrawet spreader, was used in four applications on sweet corn. Gesarol A-5 dust was also used in a similar schedule. Counts of tassel breakage as an index of stalk infestation, made just before harvest, showed no breakage at all in DDT plots (either sprayed or dusted) and only 9.5 percent breakage in untreated checks.

Yield records showed 2 infested ears out of a total of 265 (0.75 percent) in the plots sprayed with DDT. No infested ears were found in the dusted plots. Unsprayed checks yielded 239 ears, of which 4 (1.7 percent) were damaged by corn borer.

The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts. (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) The set of fruit was so light and uneven that the schedule of tests originally planned for this block had to be rearranged and all of the DDT series had to be relocated. Such records as were possible were taken from McIntosh plots at harvest. The crop of Baldwins, which was due to be light, was practically wiped out by the freeze and subsequent hailstorm.

Supplements to the Standard Schedule. On unsprayed trees the severe attack of all insect pests and the unusual severity of scab caused what fruit survived the early freeze and subsequent hail to drop by early August. Practically all of this was infested by scab, curculio, and codling moth.

In the plots receiving the standard schedule, there was 7.3 percent damage from curculio, 10.5 percent from codling moth, and 35 percent from scab. Only 48 percent of the fruit in this plot was free from disease or insect blemishes.

In the plot where the "emergency A" spray was interposed between the 2d and 3d cover sprays, there was 82 percent clean fruit, 3 percent showing curculio injury, 1 percent showing codling moth injury, and 13.6 percent marked by scab.

The record of apples from the plot in which the standard schedule was supplemented by the "emergency A" spray and a late application of fixed nicotine spray at mid-August showed 84.4 percent clean fruit free from all blemishes, less than 1 percent codling moth damage, and slightly less scab.

The reduction of codling moth injury following the "emergency A" spray was especially significant (from 10.5 to 1 percent), and indicated the importance of this application. The record also indicated that its timing coincided very accurately with the seasonal development of the insect.

In a separate block of McIntosh, different dosages of DDT were employed, in five applications (May 15 to July 25) following the calyx spray. The standard schedule was followed up to and including the calyx spray; and part of the block received the full standard schedule throughout the season to serve as a basis for comparison. In the standard schedule, lead arsenate was used in combination with wettable sulfur and lime. The DDT was also combined with wettable sulfur but without the addition of excess lime.

DDT (AK-40) at dosage of 1 pound and 2 pounds per 100 gallons of spray did not control curculio as well as did a combination of lead arsenate 2 pounds and DDT ½ pound, even with the addition of a fish oil sticker in the 1st cover spray. Codling moth was well checked in all DDT plots (0 to 1.5 percent injury for the higher dosages, and 2 injured apples out of 32 in the DDT plus lead arsenate plot). Scab was well controlled in all plots, indicating that the presence of DDT did not interfere with the efficiency of wettable sulfur. There was very slight evidence of damage by miscellaneous minor insect pests, and no trace of damage by apple maggot in the fruit of any of the sprayed plots.

Abbreviated Schedule. With a serious cut in the crop resulting from the killing of the blossoms by frost and subsequent cold weather, many growers were contemplating the use of an abbreviated spray schedule to give moderate protection from insect pests and particularly from apple scab of such fruit as survived, and looking forward to maintaining the trees in good condition for the following season.

One section of the orchard was given a limited post-blossom schedule or a special sulfur dust and a sulfur spray combination for scab control, a special cover spray of sulfur and lead arsenate in early June, and the first apple maggot spray on July 12.

Following the standard schedule, records showed 87 percent clean fruit, 5.8 percent injury by curculio, 2.5 percent by codling moth, 0.8 percent by scab, and 2.9 percent by miscellaneous minor pests. Following the abbreviated schedule, there was 71 percent clean apples, 2 percent damage by curculio, 5 percent by codling moth, 2 percent by scab, and 2.4 percent by minor pests. There was only a trace of apple maggot damage in the entire orchard.

Codling moth, scab, and apple maggot were well checked by a modified schedule and the foliage was maintained in good condition. Curculio damage was high following the abbreviated schedule, since no special application was made

for its control. Most of this fruit could be salvaged, however, and the trees were in good vigorous condition going into the winter.

Heavy Deposit-Building Dust Against Late Codling Moth. The dusts were used in three applications covering the period from July 12 to August 9, which spanned the period of heavy hatching of eggs and appearance of late season larvae of 1st brood codling moth and of early 2nd brood larvae.

The heavy deposit-building dust proved somewhat superior to spraying, and the standard dust was approximately equal in value to spraying. Against apple scab (in a season of exceptionally heavy infection) the heavy deposit dust gave protection very comparable with the spray. The standard dust was less effective. Late summer damage by miscellaneous insect pests was uniformly low in all plots, and apple maggot injury was nil.

Insecticides for the Control of the European Corn Borer. (A. I. Bourne.) Some corn borer moths emerged before the corn had appeared above ground, the first recorded emergence being April 30. The period of emergence was prolonged over a number of weeks—considerably longer than normal—and evidently the unfavorable weather interfered to such an extent with moth activity that the first brood of borers was negligible. This was evidenced by the scarcity of egg masses and by the record of tassel breakage, counts of which were made in the experimental fields just before the crop was picked. In the check plots the percentage of infested tips was 9.5, while in the treated plots the percentage varied from 0 to 2.4, with a weighted average of 1.4 percent. The very light infestation was further shown in the yield records. The yield in *all* plots was 1532 ears, of which only 15 were found infested. In all the treated plots, 1293 ears were harvested, of which 11 (0.8 percent) were infested. Unsprayed check plots yielded 239 ears, of which 4 (1.7 percent) were infested.

Even with such a slight infestation, the percentage of marketable corn in proportion to total yield reflected the effect of the borer attack. At the first picking the yield in sprayed plots ranged from 44 to 68 ears per plot; in the check plot only 23 ears were ready to pick. In the treated plots 96 to 100 percent of the total yield was of marketable grade; in the unsprayed check, 91 percent.

Potato Spraying Experiments. (A. I. Bourne.) Flea beetles were normally abundant early in June, and the second attack occurred in late July and August. No leafhopper infestation occurred, and there was no serious threat by aphids. A small attack appeared in July, but an application of nicotine sulfate checked it before more than a very light attack developed.

The plots were given twelve applications between June 11 (flea beetles appeared about June 8–9) and September 11, when no new growth was taking place. No evidence of injury to vines following any of the sprays was noted.

The most significant differences in flea beetle damage were between the DDT plot (attack very light) and the Dithane plots (attack very severe). In both the Bordeaux and the Dithane plots the addition of calcium arsenate materially reduced the severity of attack. This was especially noticeable in the case of Dithane, which appeared to give very little protection from flea beetle when used alone. There was no significant difference between the two strengths of Bordeaux, but there was a very appreciable reduction in all cases where calcium arsenate was used. Flea beetle damage in the DDT plot was insignificant throughout the season. As the season progressed, the increased injury by flea beetles in the Dithane plots indicated that the repellent action of sprays in near-by plots might have driven the beetles to the Dithane-sprayed plants. The sharp decline in leaf perforation following the application of calcium arsenate indicates that the arsenical is essential when Dithane is used.

The damage caused by abnormal weather conditions was so severe that yield records could be taken from only 50 feet of row across the north (higher) end of the plots. The crop throughout the entire field was much lower than normal.

The yield in the plots receiving standard 10–10–100 Bordeaux and 10–5–100 Bordeaux was approximately 195 bushels per acre in both cases. Where calcium arsenate was added to Bordeaux, the yield was approximately 35 percent greater.

The lowest yield occurred where Dithane alone was applied. When calcium arsenate was added to Dithane, the yield was about 50 bushels per acre greater and only slightly less than the yield in the standard Bordeaux plot where calcium arsenate was included and greater than in the low-calcium Bordeaux plots. Dithane appeared to have held blight in check to a degree at least comparable with Bordeaux in spite of the adverse weather conditions and the inferior appearance of the plants throughout late summer.

The highest yield in the entire field was in the plot where DDT was applied (273 bushels per acre compared with 261 bushels per acre following standard Bordeaux plus calcium arsenate). This was in line with the superior vigor and excellent appearance of the plants in this plot throughout the season.

Reports that DDT is a very good insecticide for potatoes seemed to be borne out in 1945. No aphis infestation developed in the DDT plot although a slight infestation started in other plots. There was a very conspicuous reduction in flea beetle damage and the highest yield in the whole field. The plants were more vigorous throughout the season and remained green longer than in any other part of the field. The results here correspond very closely with those reported from other regions and were so generally favorable that this material may be expected to become an important element in the spray program for potato pests.

Control of Onion Thrips. (A. I. Bourne.) A spray of a 4 percent derris (4 pounds per 100 gallons) with Ultrawet wetting agent gave 90.5 percent control of thrips, DDT (0.4 pound per 100 gallons) 89.1 percent control, and Lethane B-72 (3 pounds per 100 gallons) 48.2 percent control, as compared with 91-92 percent control following application of Black-Leaf 40 with the same wetting agent.

A 5 percent DDT dust gave 90 percent control in one test and 93 percent following a heavy application. A 1 percent rotenone dust furnished 81 percent protection, and a Lethane dust (B-71) 78 percent control in light application and 95 percent following a very heavy dusting.

The wetting agent Triton X-100 appeared to be very well suited for use on the smooth waxy surface of onion plants and improved the effectiveness of all spray materials greatly, derris spraying giving 98.9 percent control, and DDT 99.4 percent immediate control with marked residual action. Lethane B-72 gave 96 percent control but no prolonged protection.

No injury was noted following the application of any of the above materials.

Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb and Wm. Garland, Waltham.) A paste containing a naphthalene base fumigant was developed for painting on steam pipes to eliminate the use of vaporizing units. Experimental fumigations on carnations with this paste at 70°–75° F. for a 6-hour exposure gave satisfactory control of the common red spider at dosages of 6/10 ounce and 8/10 ounce per 1,000 cubic feet, but were unsatisfactory at a dosage of 4/10 ounce per 1,000 cubic feet. Potted cucumber and tomato plants were slightly injured by the treatment.

Biology and Control of the Red Spider Mite on Greenhouse Crops. (W. D. Whitcomb and Wm. Garland, Waltham.) Tests of three commercial spray materials containing 5.4 percent and 3 percent rotenone in four applications at

weekly intervals to greenhouse roses indicated that they will not give good commercial control of the red spider mite under these conditions. In experiments where a partially satisfactory kill was recorded, a severe infestation developed soon after spraying was discontinued.

An experimental benzene mixture killed the red spider mite well but caused excessive injury to rose foliage, while an emulsified monochlor naphthalene mixture was both injurious to rose foliage and ineffective against the mite.

Control of Cabbage Maggot. (W. D. Whitcomb, Waltham.) With a moderate field infestation by the cabbage maggot, untreated plants of the Early Jersey Wakefield and the Charleston Wakefield varieties were 94 and 88 percent free from injury, indicating considerable resistance compared to Golden Acre and Super Curled Savoy with only 47 and 12 percent of the plants free from injury. On Golden Acre one application of 4 percent calomel–talc dust in a small mound about the stem of the plant gave perfect protection and produced 90 percent salable heads. Corrosive sublimate solution (1 ounce in 10 gallons of water) in two applications gave 95 percent protection. DDT–talc dust containing 5 percent DDT, when applied twice at weekly intervals with a hand duster, gave 95 percent protection and was more effective than a 3 percent DDT–talc dust applied either with a duster or in a mound around the stem of each plant. A DDT solution containing 1 percent DDT applied in the same way that corrosive sublimate solution was used was quite effective but caused injury to the roots of the plant, apparently due to the action of the solvent rather than of the DDT.

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) In laboratory poison studies, spray suspensions containing 2 pounds or more actual DDT in 100 gallons gave reasonable control of the plum curculio. Two pounds of actual DDT in 100 gallons were approximately as effective as 4 pounds of lead arsenate. The time required to kill the beetles and the number of punctures made in sprayed apples decreased consistently as the amount of DDT in the spray was increased, and a spray containing 4 pounds of actual DDT in 100 gallons of water (0.5 percent DDT) gave almost perfect protection. Combinations of lead arsenate and DDT were generally more effective than equal amounts of either material alone. A combination of 4 pounds of lead arsenate and 2 pounds of actual DDT in 100 gallons was very effective and highly promising for practical use.

Orchard experiments were greatly limited by a general crop failure following destructive spring frosts, and the infestation of the plum curculio was very heavy.

Applications of the regular schedule on Golden Delicious apples using wettable sulfur 4 pounds, a sulfated alcohol spreader 2 ounces, with the following materials in each 100 gallons of water gave these results:

Material		Number of Apples	Percent Free from Stings
Lead arsenate	4 pounds	2063	89.63
DDT	1 pound		
Lead arsenate	2 pounds	1472	78.47
DDT	1 pound		
Lead arsenate	4 pounds	1231	60.44
Unsprayed		173	4.62

Apple Maggot Emergence. (W. D. Whitcomb, Waltham.) The emergence of apple maggot flies in orchard cages at Waltham occurred at about the normal time although the first fly was not recovered until July 1, about two weeks later than in the early season of 1944. The peak of emergence occurred on July 18.

	Orchard Cage
First Fly Emerged	July 1
25 percent of flies emerged	July 8
50 percent of flies emerged	July 15
75 percent of flies emerged	July 19
Last fly emerged	August 5
Percent of maggots which transformed	42.66

Control of the Squash Vine Borer. (W. D. Whitcomb, Waltham.) Further tests of the susceptibility of varieties of *Cucurbitaceae* indicated that all varieties of *Cucurbita moschata* are immune to attack by the squash vine borer. In 1945 no infestation was found in the Cushaw, Longfellow Pumpkin, Alagold, Large Cheese Pumpkin, Tennessee Sweet Potato, and Butternut varieties, all of which belong to the species *moschata*. The infestation in four species of *C. maxima* averaged 5.45 borers per vine, and in six species of *C. pepo* 3.47 borers per vine. Cucumber, cantaloupe, and watermelon were also immune to attack by this pest.

Biology and Control of the Celery Plant Bug. (W. D. Whitcomb and Wm. Garland, Waltham.) Unfavorable weather conditions in May and early June reduced the first generation of the celery plant bug, *Lygus campestris* L., to a minimum and the results of experimental field studies were insignificant.

The second generation was moderately abundant and caused severe injury in the form of "black heart" to all of the untreated plants of the second planting of celery. In the field where untreated celery was infested with 12 to 70 bugs per 10 plants, DDT–talc dust (containing 3 percent and 5 percent DDT) prevented reinfestation for 33 days; and sabadilla-lime dust (containing both 20 percent and 50 percent sabadilla seed) gave protection for 14 to 19 days. These treatments produced 70 to 80 percent marketable plants which were free of black heart at harvest. Dusts containing pyrethrum and rotenone killed the celery plant bugs but permitted reinfestation after 5 to 7 days.

Biology and Control of the Grape Cane Girdler. (W. D. Whitcomb and Wm. Garland, Waltham.) In laboratory insecticide experiments, none of the canes sprayed with DDT was girdled, and no eggs were laid on them. Beetles confined with DDT-sprayed canes lived about half as long as those confined with canes sprayed with lead arsenate and cryolite. The number of feeding scars was reduced proportionately. The use of freshly cut terminal grape canes in cages greatly simplified this type of insectary studies, compared with the potted grape vines which were used previously.

Sprays to Prevent Scolytid Infestation of Elm Logs. (W. B. Becker.) At Springfield, the following spray mixtures were applied once to the entire bark surface of elm logs before scolytids could attack them in the spring. The logs used in the different tests were up to 8 and 14 inches in diameter with bark up to one half and one inch thick. The percentages of prevention of scolytid infestation are based on the number of exit holes per square foot of bark in the late fall as compared with unsprayed logs. *Scolytus multistriatus* Marsham was the only or the predominant scolytid in the logs. The figures in parenthesis following each spray mixture indicate the proportion of ingredients and the amount of spray applied per square foot of bark.

	Percent Prevention
Gesarol A-20 (20% DDT wettable powder) and water	
(18 grams—3785 cc., 195 cc.)	90.3
Gesarol emulsion (20% DDT) and water	
(1-400,185 cc.)	84.0
(1-200, 179 cc.)	94.5
Kerosene alone (135 cc.)	98.8
Used crankcase oil alone (169 cc.)	94.6
No. 2 fuel oil alone	
(42 cc.)	86.1
(123 cc.)	100.0
(166 cc.)	99.2
(213 cc.)	100.0
Orthodichlorobenzene and No. 2 fuel oil	
(1–4, 113 cc.)	100.0
(1–8, 54 cc.)	96.7
(1–8, 115 cc.)	100.0
(1–8, 132 cc.)	100.0
(1–12, 105 cc.)	98.0
(1–16, 107 cc.)	99.1

At the same location other elm logs were sprayed six times at three-week intervals beginning May 31, with the following results. The proportions and amounts of spray indicated were used for each application..

	Percent Prevention
No. 2 fuel oil alone (176 cc.)	100.0
Gesarol A-20 and water (18 grams – 3785 cc., 164 cc.)	84.2
Gesarol emulsion and water	
(1–400, 164 cc.)	87.1
(1-200, 158 cc.)	90.3

Sprays to Kill Scolytids Breeding in Elm Logs. (W. B. Becker.) At Springfield, the following spray mixtures were applied on July 20 to the entire bark surface of scolytid-infested elm logs up to 6 and 10 inches in diameter with bark up to one half and three quarters inch thick in the different tests. The percentages of control are based on the number of exit holes per brood gallery in the late fall compared with those in unsprayed logs. Brood galleries of *Scolytus multistriatus* Marsham were more abundant than those of *Hylurgopinus rufipes* (Eich.) in these logs. The figures in parenthesis following each spray mixture indicate the proportion of ingredients and the amount of spray applied per square foot of bark.

	Present Control
Creosote and kerosene, strained (1–4, 189 cc.)	96.5
Orthodichlorobenzene and No. 2 fuel oil (1–8, 208 cc.)	91.7
No. 2 fuel oil alone (200 cc.)	69.8
Kerosene alone (186 cc.)	59.6
Gesarol emulsion (20% DDT) and water	
(1–400, 150 cc.)	4.6
(1–200, 133 cc.)	2.3
Gesarol A-20 (20% DDT wettable powder) and water	
(18 grams – 3785 cc., 181 cc.)	0.0

At the same location other elm logs were sprayed four times at three-week intervals beginning July 20, with the following results. The proportions and amounts of spray materials indicated were used for each application.

	Present Control
Gesarol emulsion and water	
(1–400, 182 cc.)	52.9
(1–200, 145 cc.)	2.6
Gesarol A-20 and water (18 grams – 3785 cc., 172 cc.)	0.0

Although no significant reduction in the number of exit holes resulted from these DDT sprays, dead adults were occasionally found in the exit holes on some of the infested logs which were sprayed one or more times with DDT. This phenomenon was apparently not common enough in the logs sprayed with the other materials to have been noticed. To what extent the DDT residue on the surface of the bark may have affected beetles which completely emerged, was not determined.

The Control of Elm Scolytid Infestation by Solar Heat. (W. B. Becker.) Scolytid development in elm logs, up to 16 inches in diameter with bark up to 1 inch thick, piled in partial shade and left undisturbed until late October, served as a basis with which to compare the results of the several treatments. Percentages of control are based on the number of exit holes and unemerged survivors per square foot of bark.

Merely spreading uninfested logs, up to 19 inches in diameter with bark up to 1½ inches thick, singly in a north–south position in the sun on May 25 and leaving them undisturbed until late October resulted in 63.2 percent control. The upper half of the logs in the sun was free of brood galleries, except for a few almost half way down the sides of the logs (1.9 galleries compared with 7.1 per square foot scattered over the entire upper half of the control logs). On the lower half of the logs the number of brood galleries approximately equaled those in the control logs (15.3 compared with 14.5 per square foot); however, less than half as many exit holes and unemerged survivors were found there (45.7 compared with 94.6 per square foot in the controls). Both in these logs and in the control logs piled in partial shade, brood galleries of *Scolytus multistriatus* Marsham and *Hylurgopinus rufipes* (Eich.) were almost equally abundant.

When logs up to 16 inches in diameter with bark up to 1 inch thick were similarly placed in the sun on May 25, but turned over on July 12 after the lower portion had become infested, 79.6 percent control resulted.

Other logs with diameters up to 23 inches and bark up to 1 inch thick were piled in the shade from May 25 to July 12, by which time they were well infested with scolytids. On the latter date they were spread singly in the sun in a north-south position, and on August 2 they were turned over. This resulted in 95 percent control.

When logs up to 24 inches in diameter with bark up to 1¾ inches thick were spread singly north and south in the sun on May 25, turned over every week through August 17, and then left undisturbed until late October, 99.7 percent prevention of infestation resulted. Logs up to 23 inches in diameter with bark up to 1½ inches thick, which were turned in the sun every two weeks during the same period showed 98.8 percent prevention, while other logs up to 24 inches in diameter with bark up to 1½ inches thick showed 98.7 percent prevention.

When logs up to 17 inches in diameter with bark up to 1 inch thick were spread singly north and south in the sun on May 25 and sprayed on the lower half with creosote and kerosene, strained (1 to 4 by volume), over 99.9 percent prevention resulted.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Variety Improvement and Disease Resistance. (Harold E. White, Waltham.) The Helen Tobin snapdragon, a recent introduction of the Waltham Field Station, has been grown by florists in 24 different states, north as far as Bar Harbor, Maine, and south as far as Texas and Florida, and requests for seed for trial have been received from foreign countries. Many growers reported this variety as excellent in performance and regarded it as unusual in size, color of flowers, and habit of growth, and several reported it as an excellent variety for their locality.

As with any new variety of plant material, certain characters need to be improved. Therefore, commercial winter-flowering varieties of snapdragon have been crossed with Helen Tobin to obtain a wider range of flower colors. A seedling mutation of Helen Tobin, which is of a darker pink color, gives promise of improvement over the present variety and is being selected for further trial. Seed stocks of a number of first generation hybrids of snapdragons and unnamed selfed lines are being increased so that more extensive trials can be made to determine their adaptability for commercial use.

Disease Resistance and Heredity of Carnations. (Harold E. White, Waltham.) Hybridizing of commercial varieties of carnations is being continued. To date, seed production from crosses has been very low; hence large populations from individual crosses, sufficient for a thorough study of disease resistance, have not been obtained. Selections have been made from a number of seedlings from previous crosses, but these do not offer enough variability for reliable conclusions. Cultural treatments and methods of inducing more abundant seed production from carnation plants are being investigated.

Subirrigation Methods of Watering Carnations. (Harold E. White, Waltham.) The four raised concrete V-bottom benches and two ground beds, which were constructed at the Waltham Field Station in 1945 for subirrigation studies on florists' crops, were operated with carnations. Half the benches and beds were subirrigated and the remainder were top-watered in the customary manner. The plants made excellent growth under both systems. During the early fall, plants in the subirrigated benches appeared to be somewhat more advanced in growth than the top-watered; but as the season progressed, this difference became less perceptible.

The number of blossoms cut from subirrigated and top-watered plants was not significantly different. Keeping quality, size of flowers, and length of stems were equally good. Frequency of watering was reduced 50 percent by subirrigation methods as compared to the practice of top watering.

The chief advantage of subirrigation over surface watering is the reduction in frequency of watering, which under greenhouse conditions is a considerable item of expense in growing crops. Other important features are more uniform moisture conditions, better aeration of soils, conservation of plant food elements, and less danger from air-borne fungous diseases.

Subirrigation methods of watering greenhouse crops by flooding, measured injection of given quantities, constant water level, and automatic regulation are worthy of any grower's consideration. One system may be better adapted for one grower's needs than another, but there is plenty of opportunity for modification of existing methods. Automatic regulation and constant water level methods of watering are being put into operation for observation.

Treatment of Sand with Fermate for Carnation Cuttings. (Harold E. White, Waltham.) Propagating sand for use in rooting carnation cuttings was treated with dry Fermate (ferric dimethyldithiocarbamate) at the rate of 2 pounds and 3 pounds per 100 square feet. Cuttings from 12 varieties of carnations were placed in treated and untreated sand. The increase in percentage of rooting of carnation cuttings in Fermate-treated sand over untreated sand was quite variable. Eleven lots of cuttings showed increases in percentage of cuttings rooted, from as low as 1 percent to as high as 25, and six lots showed a decrease in comparison with untreated. The difference in percentage of cuttings rooted in the 2-pound and 3-pound treatments was equally variable. Rooting response to the same treatment varied with varieties of cuttings. When cuttings of a particular variety rooted poorly with no treatment, the response was poor with the Fermate treatment.

The results obtained in these tests indicate that Fermate applied directly to the sand is of no particular value for rooting of carnation cuttings. Losses from rot diseases in the cuttings were not sufficient to determine whether such treatments are effective as a means of disease control.

Sodium Selenate as a Red Spider Control. (Harold E. White, Waltham.) In tests at Waltham, the application of sodium selenate to soils in which carnations are growing has proved to be an effective means of controlling red spider. Experiments were conducted on plants grown in pots, flats, and benches. Observations were also made on plantings of treated carnations in local greenhouse ranges. Young carnation plants in flats remained free of red spider for 5 to 6 months after one application of sodium selenate to the soil in early spring. In benches, treatments made in July kept the carnations free of red spider for 10 months, whereas untreated plants became heavily infested.

Two forms of sodium selenate were used in the tests, pure selenate ($NaSeO_2$) and a commercial product known as P-40, which is superphosphate impregnated with 2 percent of sodium selenate. The pure sodium selenate was dissolved in water at the rate of 100 grams per gallon, to make a stock solution; each quart of stock solution was diluted with 25 gallons of water; and 1 quart of diluted solution was applied to 1 square foot of soil. At this rate each square foot received ¼ gram of sodium selenate. The P-40 was applied to the soil at the rate of 3, 4, and 6 pounds per 100 square feet. At these dosages red spider was effectively controlled. Although no injury to carnations was observed from the dosage of 6 pounds, a minimum rate of 3 to 4 pounds per 100 square feet was sufficient for good control. At the rate of 3 pounds of P-40 per 100 square feet, each square foot received ¼ gram of sodium selenate.

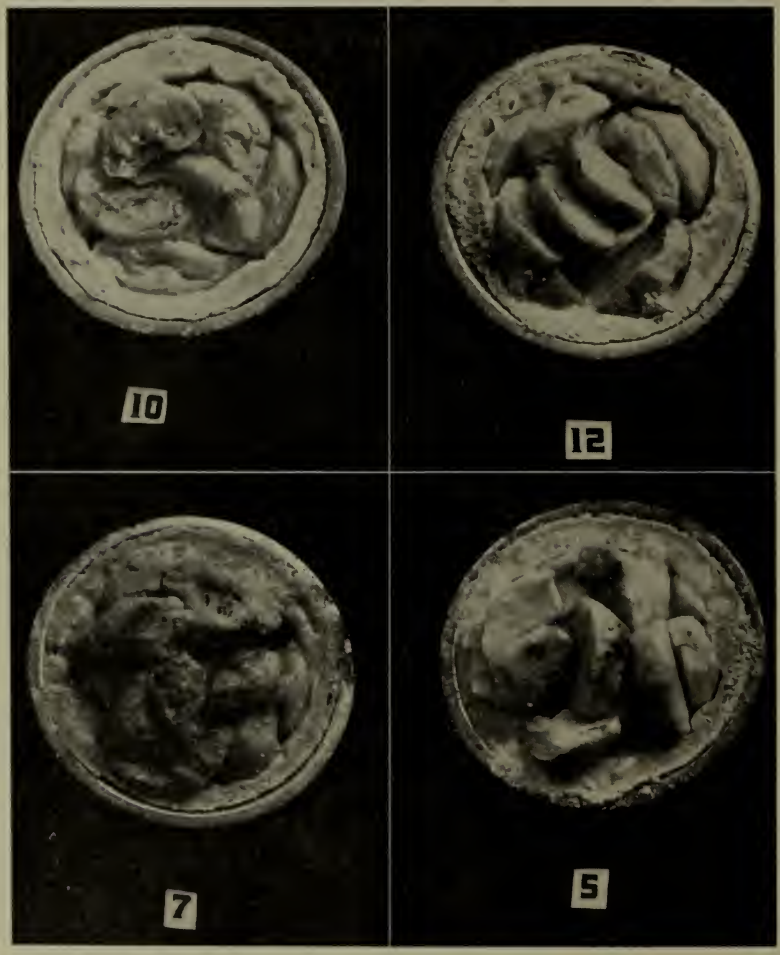
Carnation plants should be treated with sodium selenate after they are established in the soil, and at least 4 weeks must be allowed for the effect of the treatment to show. Some preliminary tests at Waltham indicated that pre-treatment of the soil with sodium selenate at the rate of ¼ gram per square foot, 6 weeks prior to planting, may be a safe procedure.

Variations in soil conditions and other factors may affect the results obtained with sodium selenate. Young, actively growing plants have been observed to respond more readily to selenate treatment than older plants. Conditions which affect movement of water into the plants are also limiting factors.

DEPARTMENT OF FOOD TECHNOLOGY

C. R. Fellers in Charge

The Use of Calcium Salts in Freezing McIntosh Apples. (W. B. Esselen, Jr., J. J. Powers, and C. R. Fellers.) In Massachusetts and throughout New England the McIntosh apple is by far the most important commercial variety. Unfortunately, this apple as grown in Massachusetts and certain other areas is usually of rather soft texture, especially after storage, and is not well adapted to freezing, canning, or bakery use. When processed by these methods the sliced apples tend to become very soft and mushy, particularly when used in pies.



UPPER: Pies Made from Fresh McIntosh Apples.
No. 10—Control
No. 12—Sliced apples treated with calcium

LOWER: Pies Made from Frozen McIntosh Apples.
No. 7—Control
No. 5—Sliced apples treated with calcium before being frozen

Experiments have been carried on during the past year with methods for increasing the firmness of sliced Massachusetts-grown McIntosh apples in order to maintain their shape during canning, freezing, and baking. The use of calcium as a firming agent is quite effective for this purpose. The amount of calcium used (such as calcium chloride) and the time of the treatment will vary depending upon such factors as the original firmness of the apples, the length of time they have been in storage, the degree of firmness desired, etc. Concentrations of from 0.03 to 1.50 percent calcium in the treating solution may be indicated depending upon the processing method and the condition of the apples These calcium treatment have been found to be just as effective with so-called. "green McIntosh" apples as with ordinary McIntosh.

Stability of Riboflavin in Processed Foods. (W. B. Esselen, Jr., A. Filios' J. Crimmins, M. W. Paparella, and M. S. Gutowska.) An investigation of the stability of riboflavin in a large number of commercially canned foods, packed in glass or metal containers is being carried on. Many different kinds of baby foods are included among the products considered. There appears to be considerable variation in the stability of riboflavin in different products, regardless of the type of container in which they are packed. The loss of riboflavin during three months' exposure to diffused daylight on a typical store shelf varied from 0.0 to 60.0 percent, depending upon the products. Such products as strained peas, liver soup, chopped spinach, vegetables and liver, red kidney beans, chopped prunes, strained and chopped beets, and chopped carrots showed only small losses; while products such as strained green beans, custard pudding, tomato juice, strained peaches, and strained tomato porridge showed greater losses. These losses tended to increase during storage for 12 months. In some cases losses, but not as great as those in samples exposed to the light, were found in both glass and tin packed products stored in the dark and at different temperatures.

To date the results show that in many glass-packed foods the loss of riboflavin during storage on a store shelf under normal conditions would be small. The results of the present investigation are in general agreement with an earlier preliminary study made with glass and tin packed asparagus, peas, corn, and green beans and show that riboflavin seems to be less stable in the more acid products.

Ascorbic Acids as Antioxidants. (C. R. Fellers, J. E. W. McConnell, J. J. Powers, W. B. Esselen, Jr., L. R. Parkinson, and G. S. Congdon.) In 1940 this department demonstrated that l-ascorbic acid (vitamin C) was an effective antioxidant in preventing surface darkening in home-canned fruits. As a result of this and later work carried on here and elsewhere, ascorbic acid is now recognized as an important antioxidant in the food industries. Today it is being used in such things as home-canned and frozen fruits, commercial frozen fruits, particularly peaches, apple juice, and certain beverages.

During the past year a study has been made of the antioxidant properties of a new ascorbic acid compound, 5, 6 diacetyl-l-ascorbic acid, which holds promise of being adapted to use where a slower-acting antioxidant is indicated. The rate of oxidation was found to be considerably slower than that of l-ascorbic acid or d-iso ascorbic acid during storage in a bottled buffered aqueous solution at pH 4.0. On an equivalent weight basis the biological vitamin C activity of 5,6 diacetyl-l-ascorbic acid was comparable with that of l-ascorbic acid as determined by guinea pig bioassay.

Further uses of ascorbic acid as antioxidants are being investigated.

There is considerable interest at present in the fortification of such juices as apple, cranberry, and grape with ascorbic acid to put them on a par with citrus

juices as sources of vitamin C. In some juices such as apple, the added ascorbic acid also serves as an effective antioxidant in preventing color and flavor changes. During the past three years, a number of tests have been made to determine the stability of added ascorbic acid in glass-packed apple, cranberry, and grape juices. In all cases the ascorbic acid was well retained during processing and storage. It is recommended that ascorbic acid, if used under commercial conditions to fortify bottled fruit juices normally low in vitamin C, be added on a basis of 50 milligrams per 100 milliliters or 190 grams per 100 gallons of juice. If the ascorbic acid is added as an antioxidant only, 75 grams per 100 gallons of juice should be adequate.

Glass-Packed Citrus Juices. (W. B. Esselen, Jr., J. E. W. McConnell, C. R. Fellers, and A. S. Levine.) Experimental test packs of bottled grapefruit and orange juices, packed in a commercial plant in Florida, have been obtained in order to study the effect of added antioxidants and storage temperatures on the quality of these products. The addition of d-iso ascorbic acid or l-ascorbic acid to bottled citrus juices seemed to have a definite favorable effect on flavor retention during storage, but was not effective in preventing darkening under adverse storage conditions—tended, in fact, to accentuate it, as has been previously reported from this laboratory. Samples of the grapefruit and orange juices have been stored at temperatures of 35°, 50°–60°, 70°–80°, and 100° F. for periods up to a year. It is recommended that glass-packed citrus juices be held at temperatures of 60° F. or lower during storage. Under these conditions the original flavor of the juices is well retained. At temperatures of 70°–80°, the storage life of glass-packed citrus juices is approximately six months.

Effect of Carbon Dioxide Gas on Color Retention in Citrus Juices. (W. B. Esselen, Jr., G. S. Congdon, and J. E. W. McConnell.) Laboratory tests have shown that if grapefruit and orange juices are saturated with carbon dioxide gas prior to pasteurization and bottling, their tendency to darken during storage is decreased. In accelerated tests the storage life of these juices (based on tendency to darken) was extended from four to six times. These findings are being checked with packs of juices put up under commercial conditions.

Home Canning Research. (W. B. Esselen, Jr., G. Lycarczyk, N. Glazier, J. E. W. McConnell, A. S. Levine, C. R. Fellers.) A comparison of time and fuel consumption was made to determine the relative efficiency of the pressure canner and water bath methods of processing for acid foods. For the urban home canner the use of a pressure canner operated at 0 to 1 pound steam pressure in place of the water bath resulted in an approximate saving of 25 percent in total time required and in fuel consumption. Recommended boiling water bath process times were used in both cases.

Excessively rapid cooling at the end of processing is an important cause of loss from home canning jars; fluctuations in pressure during processing a less important cause. Jars sealed with the zinc Mason cap and the partially sealed bail-type jars showed the greatest loss of liquid. The two-piece metal lid, three-piece glass lid, and fully sealed bail-type jars exhibited a minimum loss of liquid. The number of jars being processed, the nature of the product (slow or fast heating), and the size of the pressure canner were found to have a significant effect on the come-up and cooling times of different pressure canners.

It is frequently stated that the presence of decayed vegetables in the canned product decreases the acidity so that it is more difficult to sterilize the product. Studies have been carried out with different vegetables in which various proportions of sound and decayed product were canned. It was found that the presence of decayed peas, beans, and greens, particularly, might decrease the acidity of the jar contents to a point where a longer process time would be required.

New home canning jars, as purchased, were found to be relatively free of bacteria compared with jars which had been used and then stored for use the following season. These findings point to the desirability of thoroughly washing home canning jars after they have been emptied and before they are put away, and of washing them in hot soapy water prior to use the following season.

Investigation of Processing Methods for Home Canned Fruits. (Cooperative project with the Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (J. E. W. McConnell, W. B. Esselen, Jr., D. Anderson, I. Powers, F. Johnson, and M. Mrowkowski.) During the summer of 1945, heat penetration and processing data were obtained for home-canned rhubarb, strawberries, cherries, raspberries, blueberries, peaches, apple sauce, tomatoes, and tomato juice. In most cases the data were obtained on the products packed in both pint and quart jars and processed in a boiling water bath and in a steam pressure canner at 1, 5, and 10 pounds steam pressure. The initial temperature is important in processing home-canned fruits because of the lethal rate of the micro-organisms concerned, the rate of heat penetration into the product, and the short process time usually employed. Processing at 1 pound steam pressure in a pressure canner was found to be similar in sterilizing value and heating rate of products to processing in a boiling water bath. Any slight differences were in favor of the pressure canner.

Home Freezing. (A. S. Levine, W. B. Esselen, Jr., K. M. Lawler, N. Glazier and C. R. Fellers.) An investigation of the suitability of different varieties of fruits and vegetables, as grown in Massachusetts, for freezing is being continued. Samples of raw material for freezing have been obtained through the cooperation of the Olericulture and Pomology Departments. A survey and study have also been made in an effort to ascertain the role and importance of home freezing in Massachusetts. This study has included a suggested freezing program based on Massachusetts products, the economic aspects of freezing certain products, home freezing costs, and a comparison of freezing and canning as methods of home food preservation.

Since relatively little meat is raised in Massachusetts it is questionable whether the freezing of meat is practical. At the present time there is considerable interest in this subject as a means of having meat on hand when the supply is short; but under ordinary conditions meat may be purchased as needed. With the large number of poultry flocks in Massachusetts, poultry may well be frozen.

It has been suggested that such foods as eggs, lard, butter, and citrus juices may be purchased when the price is low and frozen in sufficient quantities to be used throughout the year. It would appear, however, that the saving which results is completely offset by the cost of packaging and of the freezing storage and by the amount of space required in the home freezing unit.

The rental of a freezer locker is definitely less expensive than an equivalent amount of freezer capacity in the form of a home freezer, but is also less convenient. Home freezing is definitely more expensive than home canning. On a basis of equipment cost and depreciation, power, containers, and storage, the unit cost of preserving food by freezing is four to five times that of canning. With good management the freezing cost may be reduced somewhat.

Home freezing is a particularly good method of preservation for strawberries, raspberries, broccoli, greens, corn, and meats. On a basis of quality such products as tomatoes and tomato juice, green beans, carrots, beets, and peaches can be preserved equally well, if not better, by canning, as shown by comparative tests carried out during the past three years.

All things considered, home freezing in Massachusetts does not appear to be as important as it may prove to be in certain other sections of the country. It would appear that home freezing may be best used to supplement rather than to replace other methods of home food preservation.

Vitamin D Investigations. (L. R. Parkinson and C. R. Fellers.) Periodic checks were made on the vitamin D content of Vitamin D milks sold in New England. These assays showed that of the 192 samples examined, 181 contained at least 400 U.S.P. units per quart, 8 samples contained from 320–400 units, and only 3 samples were seriously deficient. Direct irradiation of milk is no longer practiced in this State. The principal means of adding vitamin D to milk is by direct addition of irradiated or activated ergosterol or purified fish oil concentrate.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

Utilization of Iron in Foods. 1. By Human Subjects. (B. V. McKey, A. W. Wertz, D. C. Staples, and J. O. Holmes.) Four healthy women ranging in age from 24 to 37 years participated as subjects of the experiment. During the four and one half months of the study they received a basal diet which contained only 3.8 mg. of iron (about one-third of the amount recommended by the National Research Council as a daily allowance for women), but was adequate in all other respects. Beef muscle, approximately one fifth of a pound daily, was fed in addition to the basal diet from the 65th to the 115th day of the experiment; and iron sulfate, an iron salt frequently recommended by physicians as a source of iron, was fed in a quantity equivalent to the iron in the beef, from the 116th to the 130th day. During the experiment the four subjects donated approximately 1 pint of blood on the 1st, 15th, and 95th days, in an attempt to induce a mild state of anemia which would insure maximal use of the iron in the foods.

An anemia of clinical severity was not produced in any of the subjects. Following the second withdrawal of blood, the hemoglobin in only two of the subjects fell as low as 90 percent of that usually found in normal, healthy young women. Throughout the experiment the subjects were cheerful, energetic, and felt well. The absorption of iron was as follows:

	Percentage Absorption of Iron by the four subjects			
In the basal diet	0	3	14	23
In the beef alone	19	44	51	36
In the iron sulfate alone	0	26	37	19

The woman who utilized the least iron in each of the diets was one who had been severely anemic the preceding summer and had received iron medication under a physician's prescription. It is probable that she made such poor use of iron during the experiment because her body tissues were so saturated with iron that the withdrawal of blood did not reduce her iron stores enough to allow for absorption of new iron. The hemoglobin level of this subject after the second blood donation within a 15-day period approximated that found in normal, healthy non-donors of blood.

These data indicate that all four of the women made more efficient use of the iron in beef than in the iron salt. They also suggest that healthy women whose body tissues are filled with iron can donate blood in the amounts and with the frequency prescribed by the American Red Cross without serious depletion of their iron stores, provided their diet is adequate in protein, vitamins, and min-

erals. For continuous blood donation a level of iron higher than that used in this study would be advocated.

2. By Rats. (A. W. Wertz.) The problem of the availability of iron in foods was also studied with the use of the rat as the experimental animal. The foods studied were roast beef and boiled navy beans, both being fed in dry form. Iron sulfate was used as a standard for comparing the availability of iron in these foods. The animals received a basal ration of milk powder and were paired according to sex, weight, litter membership, and hemoglobin of the blood. The amount of iron fed in the supplement was 0.2 mg. per day; and the amount stored during the 35-day period while the rats were receiving the supplement was determined by analyzing the carcasses.

The rats receiving iron sulfate retained more iron than did their litter-mates receiving the beef or the bean supplements. When the availability of the iron sulfate was set at 100, the retention of iron approximated 60 for the cooked beef and about 90 for the dried beans. These preliminary data suggest that the iron in navy beans may be better utilized than the iron in beef. Contrary to the results obtained with human subjects, the iron sulfate appeared to be a better source of iron for the rat than did the cooked beef.

Studies Relating to the Cause of Tooth Decay. (Julia O. Holmes, L. R. Parkinson, A. W. Wertz, and B. V. McKey.) The hypothesis used in planning these studies has been (a) tooth decay is caused by the acid which is produced as a by-product of the growth of bacteria which flourish in the oral cavity, and, conversely, decay may be prevented by inhibiting the growth of these bacteria; (b) under certain dietary conditions the salivary glands secrete a substance, the anti-caries factor X, which prevents bacterial growth; (c) the factor X either is a constituent of certain foods or is manufactured in the body, possibly in the salivary glands, possibly by the bacteria in the digestive tract, from the substances contained in those foods.

During the year approximately 200 rats have been reared on the decay-producing diet consisting of coarsely ground corn, milk powder, and alfalfa meal, supplemented with various dietary factors in an attempt to find one which would prevent the rampant tooth decay consistently found in rats reared on this basal diet. These substances included beef muscle, liver, alfalfa, butter fat, yeast, a rice-bran extract, fluorine, the amino acid tryptophane, the vitamins nicotinic acid and K, a mixture of the fat-soluble vitamins, and a mixture of both the fat-soluble and the water-soluble vitamins in crystalline or concentrate form. Other groups of rats were reared on a "purified" diet consisting of casein, mineral mixture, a "complete" vitamin mixture, and either sucrose, dextrose, or cornstarch, to determine whether tooth decay can be induced in rats consuming diets which do not contain corn. A sulfa drug, succinyl sulfathiazole, was fed to groups of rats receiving (a) the corn diet in which the corn was cooked and (b) the purified diet in which the carbohydrate was starch, both of which had been found by other investigators to prevent tooth decay in the rat. The sulfa drug was given because of its "sterilizing" action in the bowel; the idea being that, if the bacteria of the bowel normally manufacture the factor X from substances in these two diets, the factor would not be made by the rats receiving the drug; hence these rats would experience more tooth decay than would be found in their litter-mates not receiving the drug.

None of the supplements fed in conjunction with the raw-corn diet caused even the slightest decrease in the rampant tooth decay observed on the basal corn diet, although some of them had been reported by other investigators as preventing tooth decay. These results led to the tentative conclusion that the

corn diet may produce decay, not because of its deficiency in factor X but because it contains some deleterious substance which either unites with factor X thus making it unavailable, or makes impossible the synthesis of factor X. Unexpectedly, tooth decay was present in an advanced state in the rats receiving the cooked-corn diet, although the incidence and extent of decay were not as great as on the raw-corn diets. This led to the conclusion that corn causes decay in the rat, not because of the hardness of the particle but because of some fundamental constituent either in the corn or lacking in the corn. If corn contains a deleterious substance, it is not found in the starch fraction of the corn, since rats fed the purified diet containing cornstarch did not experience tooth decay.

The replacement of cornstarch by cane or corn sugars in the purified diets resulted in a mild degree of decay on the grinding surfaces of the teeth. This is the first report of such a finding in the albino rat fed purified diets, although it has previously been reported that the cotton rat develops tooth decay when subjected to diets containing soluble carbohydrates. The fact that the soluble carbohydrates when fed in large quantity allow tooth decay might tempt one to conclude that the sugars are the sole cause of decay. Such a conclusion must be abandoned, however, in view of the rampant decay found in rats fed corn diets, which contain only a small amount of soluble carbohydrate—the lactose in the milk powder.

The sulfa drug did not increase the incidence or extent of decay over that found in litter-mates receiving the diet without the drug. None of the rats receiving the purified diets showed decay even though they received the sulfa drug. Likewise the cooked-corn diet plus the sulfa drug was not any more conducive to decay than the diet without the drug. These findings suggest that either factor X is not manufactured by the bacteria in the bowel, or the sulfa drug in the dosage administered does not prevent the growth of the strain of bacteria responsible for its manufacture.

Although the year's work has not resulted in data which confirm or refute the hypothesis used in planning these experiments, the study will be continued.

The Role of Calcium in the Calcification of Bones. (Marie S. Gutowska and Julia O. Holmes.) In a preliminary study of the influence of environmental temperature on calcium metabolism, growing rats held at 62°F. consumed approximately twice as much food as did litter-mates held at 87°. On analyzing the carcasses of the rats, more calcium was found in those held at the cold temperature and it was concluded that the cold temperature stimulated the storage of calcium in the rat. However, since the animals in the cold environment consumed twice as much food as those in the warm, and since the percentage of calcium in the ration was identical for both groups, it is obvious that the animals in the cold environment consumed twice as much calcium. Consequently the results obtained might have been due to differences in quantity of calcium consumed rather than to differences in environmental temperature. In order to distinguish between these two variables, temperature and quantity of food eaten, a system of feeding was devised whereby the animals of two groups would receive equal quantities of calcium but would be allowed to eat as much of the calcium-free basal food as was necessary to satisfy individual needs.

In Series 1, two litter-mate groups of animals, one held at 62°F. and the other at 87°F, were fed a diet containing 0.6 percent calcium. All were allowed to eat as much as they desired. In Series 2, three litter-mate rats were fed a small portion of calcium in a fixed daily quantity separate from the ration, which was devoid of calcium. One rat was allowed to eat as much of the calcium-free food as he desired, the second was allowed only three fourths as much food as the first, and the third was allowed only half as much as the first. In Series 3, two

groups were fed the same diet devoid of calcium, one being kept at 62° and the other at 87°. These animals were allowed to eat as much of the calcium-free food as they wished, but all were given an identical quantity of calcium separate from the ration. In all three series the animals were of the same age and were fed and cared for in the same way.

In Series 1, the quantity of ash stored by the animals was dependent on the quantity of food eaten; those eating the smaller amount of food had the smaller amount of ash in their bones, whereas those eating more food had the greater amount of ash. In contrast, the rats in Series 2 stored almost identical quantities of ash in their bones, irrespective of the quantity of food eaten. In Series 3, the rats reared at 62°F. had no more ash in their bones than did their litter-mates reared at 87°.

These results show the importance of controlling the intake of calcium in studies which are concerned with the growth and calcification of the skeleton.

DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

Study of Herbaceous Perennial Material. (C. J. Gilgut, Waltham.) The perennial test garden with its extensive collection of labeled plants is the only one of its kind in New England. It is of value to nurserymen, landscape architects, students, and the gardening public, who wish to observe and study the response of various plants to our local climatic conditions. At present, it contains about 2500 plants, many of which are old garden favorites. There are also many new varieties, recently introduced into the trade, and some placed here by a number of hybridists, for comment and report as to garden value, cultural requirements, and winter hardiness.

Probably more new varieties of the so-called hardy chrysanthemum are being developed and introduced today than of any other garden flower. The collection here includes many, but not all, of the better introductions of the Korean hybrids from Bristol Nurseries, and the hybrids from the University of Minnesota, University of Chicago, University of New Hampshire, Colprit Nurseries, and the United States Department of Agriculture. Although these chrysanthemums are considered hardy, they have not been found reliably so in the test garden and it has been found necessary to resort to wintering them in cold frames to insure against loss by winterkilling.

The extensive collection of tall bearded iris suffered considerably from winter injury, which was followed by much soft rot of the older rhizomes, in spite of a mild winter and a good blanket of snow. There was more loss in the recently transplanted iris than in those established for a year or more. Mulching the first winter after transplanting might have prevented much of this loss.

Factors Influencing the Rapidity of Growth of Nursery Stock. (C. J. Gilgut, Waltham.) In a propagating medium of sand–peat in which a previous batch of cuttings had rotted badly, several materials commonly recommended for sterilizing media were tried. The dry chemicals were scattered over the sand–peat, and the formaldehyde sprinkled on with a watering pot. Each was then thoroughly worked into the medium and cuttings of *Taxus media hatfeldi* were inserted. The materials used and the effect on rooting of cuttings are shown below.

Material	Amount per Square Foot	Percentage of Cuttings Rooted In 9 Weeks	In 20 Weeks
Untreated			92
Formaldehyde	2.5 cc.	88	93
Potassium permanganate	7 grams	86	95
Fermate	28 grams	6	70
Spergon	14 grams	12	50

Rooting was quicker and better with the formaldehyde and potassium permanganate treatments than in the untreated medium. Fermate and Spergon prevented rot, but had a decidedly retarding effect on rooting. Apparently, when propagating media are to be used again, the preferred treatment is either formaldehyde or potassium permanganate.

In a comparison of the root-promoting substances, Hormodin No. 2 and Hormodin No. 3, in used sand treated with formaldehyde 2.5 cc. per square foot or with potassium permanganate 7 grams per square foot, better and quicker rooting was obtained with Hormodin No. 2. In the formaldehyde-treated sand Hormodin No. 2 gave 96 percent rooted in 10 weeks, against 80 percent for No. 3. In the sand treated with potassium permanganate, the percentage rooting in 10 weeks was 96 for Hormodin No. 2 against 86 for No. 3.

Control of Weeds in the Nursery by Chemical Sprays. (C. J. Gilgut, Waltham.) During the past season, Savasol No. 5, one of the oils which has found such a definite place in the commercial growing of carrots and parsnips, was investigated for control of weeds in the nursery. Nearly all the common weeds were quickly killed, especially when they were small. A few, notably ragweed (*Ambrosia artemesiifolia* L.), wild chamomile (*Matricaria suaveolens* (Pursh) Buchenau), and fleabane (*Erigeron canadensis* L.), all of which are in the family Compositae, were highly resistant to the oil and both young and old plants usually survived even thorough soakings.

Applications of undiluted oil were made with a 4-gallon sprayer equipped with a Skinner greenhouse irrigation nozzle, ST 50, which gives a flat fan-shaped spray. A flat spray is better than a cone-shaped for it wets the weeds better and is more easily controlled so that less oil gets on the nursery plants. The spray was directed at the weeds, and in the case of tall nursery plants the lower foliage of these plants was also wet. With the smaller nursery stock, it was necessary to wet the entire plant in order to wet the weeds.

On hemlock there was no injury to the older leaves, and slight injury to the soft, tender new needles but not enough to retard growth. Arbor vitae was likewise highly resistant, and young plants 12-15 inches tall showed only slight yellowing of foliage. Norway spruce and Colorado blue spruce, as well as white pine and Scotch pine, showed little or no injury. The most tolerant of all the evergreens tested was *Juniperus virginiana glauca*, which showed only a slight yellowing of some of the needles and no bark injury when sprayed much more heavily than is needed to kill weeds.

On *Taxus* spp. the spray injured the leaves and caused considerable defoliation as well as some bark injury, and it definitely is not safe on this group of plants. In general, on broad-leaf plants, evergreen and deciduous, there was considerable injury to the leaves, and to the bark in many cases if wet to any extent.

Although most of the narrow-leaf evergreens are highly tolerant to Savasol No. 5; as with other chemical sprays, caution should be used that too much spray does not get onto the plants. A careful operator, using a flat fan-shaped spray, can kill weeds close to the plants in a nursery row quickly and efficiently with a minimum of injury to the stock.

DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

Asparagus Investigations. (Robert E. Young, Waltham.) Growing conditions of the two preceding years reduced the 1945 asparagus crop at the Waltham Field Station to 56 percent of the 1944 crop. A reduction of 10 to 20 percent in the stalk count taken in the fall of 1944 was due to the unfavorable weather during the growing season. Selections Nos. 1 and 4 have yielded almost twice as many spears as the commercial strain in the past; and even though the total yields were greatly reduced, this ratio was about the same in 1945. The average weight of spears was only slightly less than previously, and most of the reduction was in the number of stalks. There was no change in the percentage of the two top grades as compared with 1944.

In the spring of 1945 a new generation of roots was set. Besides several commercial varieties, these included many combinations of best male and female plants from the plantings mentioned above. To obtain information on inheritance of yield characteristics, portions of the same female plant were crossed with two or more male plants. Two low-yielding plants, one male and the other female, were also used in crosses. Nineteen different strains and varieties were planted in three replications. The plants made vigorous growth and only 19 out of 1900 died. It may be only a coincidence that 7 of these were from one of the commercial strains. Those that died were not the small ones; in fact the average weight of these crowns was greater than the average for the entire lot of plants, which was 58 grams.

In the fall a count was made of the number of stalks produced by each strain during the summer, and the average per plant varied from 5.11 to 14.41. The commercial varieties and those crosses involving one or more low-yielding parents produced the fewest stalks. Such a variation might be presumed to depend to a large extent upon the original weight of the crowns when planted, but the strain which produced the least stalks had the largest crowns. There was little or no correlation between the original weight of the crowns and the number of stalks produced. While the number of stalks an asparagus plant produces in the first year's growth is not a sure criterion of future yield, data on second-generation plants show that the production of a large number of stalks in the first year is correlated with future high yields.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.) During the year breeding work has been conducted with broccoli, greenhouse cucumber, celery, rutabaga, New York type lettuce, tomato, carrot, and Butternut squash. While progress has been made in the development of strains of carrot, celery, New York type lettuce, rutabaga, and greenhouse cucumber better adapted for local use, it is insufficient to justify detailed discussion.

Broccoli. Lack of uniformity in time of maturity and plant type in commercial varieties of broccoli was the reason for starting a breeding project on this crop. The variation in maturity of plants is demonstrated by two commercial varieties in our spring crop. By June 15, a date in midseason when all center heads should be ready if the crop is to be profitable, 41 percent of the plants from one of these varieties had been cut and 64 percent from the other. The best of the breeding lines set in the same field at the same time had produced 98 percent center heads. Other selfed lines ran from 47 to 93 percent, depending on the number of times selfed. This self-pollination has produced the desired uniformity in type and maturity but has reduced vigor and narrowed adaptability.

In order to produce a large supply of seed of one selfed strain, R-45, the plants were allowed to cross-pollinate among themselves. This massing improved vigor while maintaining uniformity. This strain, which was grown in a large block, proved to be the most outstanding broccoli ever grown here and had produced 89 percent of the center heads by June 15. It will be tested once more to be sure of its seasonal adaptability before being released to growers.

Results of this project indicate that while some strains are adaptable for both spring and fall crops, most are satisfactory only for the season for which they are bred. If the plants are self-pollinated more than two or three times, the loss of vigor is so great as to make them commercially worthless.

Butternut Squash. In 1943, local growers asked for a better, more uniform strain of Butternut squash. Trials of commercial and growers' strains indicated considerable variation, and some strains had a large percentage of the crop that was not marketable.

There was particular objection on the part of growers to cracking, crooked or curved fruit, and too great length. The breeding program is an attempt to combine the best of these characteristics in one strain. In 1945 the crop from the commercial strains varied from 0.6 percent to 12.8 percent crooked fruit, and from 19.4 to 42.9 percent cracking. No. 1 fruit—that is, squash of the desired size and shape and not cracked—varied from 227 to 345 boxes per acre.

During 1944, some of the best strains were self-pollinated, and these were grown during 1945. Some of the selfed lines possessed most of the characters desired and seemed quite uniform. The best of them had only 11 percent cracked, 6.7 percent crooked, 0.7 percent long, 7 percent small or misshapen; and a total yield of 520 boxes per acre. The yields from these lines varied from 407 to 607 boxes per acre, but the highest yielding strains had the greatest percentage of cull fruits, so the yield per acre of No. 1 fruit (not cracked) was only 394 boxes.

There is also the problem of obtaining a squash that will keep in storage and that does not shrink or shrivel. All the selfed squashes were placed in storage and weighed at intervals. The loss in weight from October 6 to December 19 was 12 to 14 percent, and the total loss to January 3 averaged 20 percent. These figures represent shrinkage only and do not include loss by rots. Unless a means can be found to reduce the shrinkage, the Butternut squash cannot be stored economically. Careful handling from field to storage is very important in the prevention of loss in storage.

In some tests to determine the carotene content and its relation to color of flesh, it was found that a dark color of flesh was not always an indication of high carotene. One lighter-colored squash had 2.14 milligrams carotene per 100 grams, which was next to the highest carotene content found.

In some preliminary trials on spacing Butternut squash, the number of fruits per plant increased with the increase in space, as follows: 6 x 6 feet, 1.90; 8 x 8 feet, 3.04; 10 x 10 feet, 3.87; and 12 x 12 feet, 5.92. There was very little difference in the average weight of the squash. While these trials were not replicated and were on a poor part of the field, the total yields per acre did not vary much from one spacing to another. It seems, therefore, that Butternut squash can be grown at spacings of 10 to 12 feet with satisfactory results.

Trellis Tomatoes. Trials of several varieties and strains of tomatoes were conducted. During the early part of the growing season of 1945 the weather was cold and wet and not conducive to good setting of fruit on the first hand or blossom cluster. In early July counts were made to determine whether there was any variation in set among varieties and strains. One variety had set an average of only 0.5 fruit per first cluster while another had set 3.7 fruits. Some

varieties the percentage of set was: Waltham Forcing, 65; Trellis No. 22, 51; percentage basis this variation was from 19 to 65 percent. For the different varieties the percentage of set was: Waltham Forcing, 65; Trellis No. 22,51; commercial Comet, 44; Stokesdale, 33; Valiant, 33; Marglobe, 41; Mass. A 13, 45. The most promising selections from the breeding work set fruit as follows: Selection 1, 36 percent; Selection 2, 36 percent; and Selection 3, 49 percent. The extreme importance of a good set of fruit on the first hand or cluster can be realized from the fact that the first fruit brought 24 cents per pound while later in the season the price went down to 4 cents.

Yield data from the selections indicate that none of the strains is superior in early yield to either Trellis No. 22 or Waltham Forcing. Selections 1 and 3 produced the greatest total yield. There was less cracking in all three selections than in Trellis No. 22 but more than in Waltham Forcing. Further testing of these selections is necessary to determine whether any are superior to those now being grown.

In the trials of new varieties grown without trellis, Red Cloud from Nebraska Agricultural Experiment Station was outstanding in the production of early fruit. It produced twice as many early No. 1 fruits as any other variety except Pennheart. Red Cloud produces fruit of size and shape more acceptable to the Boston market than Pennheart. Very few of the fruits crack or sunscald. Its disadvantages are poor color and lack of firmness compared with the trellis type tomato. Both Red Cloud and Pennheart are determinate varieties and cannot be grown on trellis. Of the trellising type tomatoes which were grown flat, Waltham Forcing produced the most early No. 1 fruits.

Weed Control in Vegetable Crops. (William H. Lachman.) The search for selective weed killers for vegetable crops has been continued. Sinox and Dow Selective Weed Killer belong to a group of chemicals known as dinitro compounds and these have been found valuable for killing weeds in peas, corn, and onions. In tests on the Experiment Station plots, these compounds were very effective in killing broad-leaved weeds but were of little value against grasses. More often than not they caused damage to the crops, depending upon the intricate combinations of weather conditions. On several occasions Sinox gave very good weed control in plantings of sweet corn with little crop damage, but in a number of other tests the corn leaves were scorched badly by the spray.

The new hormone weed killer, 2, 4-D, was also used in sweet corn but caused severe epinasty of the corn leaves. Almost all of the broad-leaved weeds were controlled satisfactorily, but the grassy weeds were unharmed.

A 2 percent solution of sulfuric acid killed many broad-leaved weeds in plantings of seedling onions but had little effect on grasses. The corrosive action of the acid on metal and clothing and its hazardous nature in general preclude the use of this method of weed control.

Frequently asparagus growers have difficulty eliminating weeds from their fields, particularly after the cutting season is over. A very potent weedicide, Dow Contact Weed Killer, was found to be especially good for this purpose. The spray should be directed down around the basal stalks of the asparagus plants for it kills the leaves or fern-like portion of the plant if these are wet by the spray.

The use of Stoddard Solvent as a weed killer in fields of carrots and parsnips was widely accepted by vegetable growers during 1945. Approximately 500 acres were treated in this manner and the growers were agreed that this was an ideal method of weed control since less labor was required, it was cheaper, and the job was done more quickly.

Stoddard Solvent is best applied when the weeds are small, since the weeds are more easily killed when young and the crop is benefited by early weed removal.

All annual weeds encountered, except ragweed, were killed by 100 gallons of the oil per acre. The carrots were relatively unharmed by the spray under most conditions, but the oil caused a scorching of the older leaves when the spraying was done while the leaves were wet.

The oil is highly volatile and does not leave any toxic residue in the soil. The oily flavor is dispersed from the carrot plant after a period of about fourteen days. Since the carrots and parsnips are not killed by this treatment they must be thinned as usual.

Young celery seedlings are not harmed by the oil, but half grown and older plants are considerably damaged. Most other crops including beets, cabbages, peppers, onions, asparagus, spinach, lettuce, turnips, and radishes are damaged or killed by Stoddard Solvent.

This oil can be used as a pre-emergence spray with susceptible crops; that is, the soil is sprayed just before the seedlings of the crop emerge from the soil. Crops of spinach, beets, and onions have been successfully weeded in this manner.

Breeding Sweet Corn, Peppers and Field Tomatoes for Massachusetts. (William H. Larchman.)

Sweet Corn. The development of inbreds or parent strains of corn has been the major objective of this project until last year. A number of the inbreds have reached a remarkable degree of uniformity in most of their plant characteristics and now many of these have been cross-pollinated in various combinations to test their relative value as parents for the production of hybrid sweet corn. One of these strains has shown itself to be a good seed parent and has been named Mass. 32. A large western seed house has increased the supply of this seed to 1500 pounds and it is now ready for use as a parent in production fields.

Mass. 32 has been found to make an excellent hybrid when crossed with Connecticut 42. The hybrid is essentially an early Golden Cross Bantam and seems to be well adapted to Massachusetts conditions. It has an ear of good size and quality and matures about one week earlier than Golden Cross Bantam.

Several other experimental hybrids looked very promising in 1945, but further testing is necessary before their merits can be established.

Peppers. The object of this work has been to develop an early, high-yielding, thick-fleshed pepper of the California Wonder Type. A number of selections from commercial varieties and some hybrids among these have been grown in an effort to achieve this goal. This project has not yet progressed to the point where results are forthcoming.

Tomatoes. There is need for a large, early, smooth fruited tomato variety with high yielding ability. Selections from commercial varieties have been intercrossed and further selections from this material have been made for several years. A number of promising strains have been developed, but they have not reached the desired degree of uniformity or excellence and none have yet been released for trial among vegetable growers.

The Culture and Nutrition of Vegetables. (William H. Lachman.)

1. Straw, sugar cane fiber, and horse manure were used as mulching materials for Rutgers tomatoes. The plants were grown unstaked and unpruned, and the treatments were replicated three times. These treatments were responsible for wide differences in yield in comparison with the control plots. The highest yield was harvested from the plots with the horse manure mulch; the lowest from those mulched with sugar cane fiber. The latter had a distinct depressing effect upon both vine growth and yield.

2. Carrot varieties and strains are planted each year to evaluate the various kinds, and these are generally tested for carotene during various stages of development and after they have been in cold storage for several months. It was plainly evident that the carrots were significantly lower in carotene in 1945 than they had been for a number of years. The only explanation that could be given was the great amount of cloudy weather and excessive rainfall during the growing season.

3. Tomato varieties with a determinate habit of growth, such as Pennheart, nearly always shed most of their leaves shortly after the ripening of the earliest fruit. The drain of food reserves from the leaves by the heavy set of fruit has been considered responsible for this condition. After various degrees of blossom removal, it was clearly evident that there was a negative correlation between the fruit load on the plant and retention of its foliage.

4. A peculiar chlorotic mottling of the leaves of greenhouse tomatoes has appeared for several years, very similar to the symptoms of magnesium deficiency; but large applications of magnesium as magnesium sulfate and high magnesium limestone failed to correct the condition. High potash supplies in the soil often aggravate magnesium deficiency in plants and the soil in question is well supplied with potash. Applications of potash are now being withheld from some of the plots in an attempt to determine whether an excess of potash is causing the trouble.

DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The Influence of Various Clonal Rootstocks on Apple Varieties.[1] (J. K. Shaw and W. D. Weeks.) For three successive years, spring frosts have interfered with a full crop in the large clonal rootstock orchard. As cold injury varied in severity with variety and in different parts of the orchard, it has invalidated yield records, but records of growth and bloom are still dependable. The trees are now growing vigorously. Results of an experiment like this come slowly, but the next few years should show interesting results.

An orchard of 256 trees of 16 varieties all on Malling IX was planted in 1943. There was some bloom and fruit last year and in 1946 nearly all varieties bloomed freely and set a fair to good crop in spite of spring frosts. The orchard is on higher ground than the orchard referred to above. There was little bloom on Northern Spy and Red Spy, but only four trees of the remaining 224 trees of 14 common varieties in the orchard failed to bloom. The trees have been in cultivation and are growing vigorously.

That Wealthy is very much dwarfed on Malling I while McIntosh on the same rootstock makes a typical semi-dwarf tree has been confirmed by further observations.

Lethal Incompatabilities Between Clonal Stocks and Varieties of Apples. (J. K. Shaw and W. D. Weeks.) Further studies of the lethal McIntosh strain R show that buds from the original tree of this strain failed to survive on the rootstock Spy 227. Evidently the lethal factor is present in the original tree. Failure resulted when both strain R and the non-lethal strain G were budded together on Spy 227. Evidently strain R is always lethal to Spy 227. Strain G wes budded on a tree of strain R and buds from the resulting shoot were budded on

[1]Two papers reporting on this project will appear in Vol. 47 of the Proceedings of the American Society for Horticultural Science.

Spy 227. At the same time buds from unbudded branches of the same tree of strain R were set in other Spy 227 rootstocks. At the present writing two trees of strain R have died in typical fashion, while all the trees of strain G are normal. This suggests that the lethal factor cannot pass into strain G and that strain G cannot communicate resistance to strain R; but the final conclusion cannot be reached until more time has passed.

Some trees of Starking grow very poorly on certain clonal rootstocks; they blossom very early in life and may die or, in some cases, seem to recover and grow better. Other trees of Starking grow normally on the same rootstock. Three-year-old trees budded from such weak and vigorous trees of Starking show the same difference. Those growing from weak trees are much less vigorous and some will probably die, while buds from the vigorous trees are growing normally. There seem to be two "strains" of Starking trees. Whether the trouble is a virus is not known.

Tree Characters of Fruit Varieties. (J. K. Shaw, A. P. French, O. C. Roberts, and W. D. Weeks.) The study of new varieties is a task without end. In the last report it was stated that Van Buren was the only bud sport that could be distinguished from its supposed parent variety, Duchess of Oldenberg. An examination of the original tree of Van Buren and propagation of buds from a normal branch and the sporting branch of this tree, and comparison with trees known to be Duchess of Oldenberg, has revealed that the original tree is not Duchess of Oldenberg but some other variety at present unknown. This single exception to our usual experience that red bud sports cannot be distinguished from the parent tree by nursery trees is thus removed and the general statement holds true. It is not correct to call Van Buren the Van Buren Red Duchess.

The inspection of nurseries for trueness-to-name was carried out in 1945 and is now in progress for 1946 on a somewhat enlarged scale.

A bulletin on the identification of blueberry varieties has been published.

The Nature of Winter Hardiness in the Raspberry. (J. S. Bailey, A. P. French, and R. A. Van Meter.) Canes of the six varieties, Marcy, Washington, Taylor, Milton, Latham, and Chief, were forced in the greenhouse at weekly intervals as in the fall of 1944. Again Chief and Latham were the slowest to start; Marcy and Washington started most readily; Milton and Taylor were intermediate. Milton behaved about as in 1944 but Taylor started much more readily. The rest period for all was over about a week later than in 1944.

Although the winter of 1945–46 was not severe, a large amount of cane killing occurred on all six varieties, undoubtedly caused by a very heavy infection of spur blight. Fermate sprays are being used to eliminate this source of trouble.

Comparison of Cultivation and Sod Mulch in a Bearing Orchard. (J. K. Shaw.) This project, which was started many years ago, has developed into a study of the mineral nutrition of apple trees, with special emphasis on magnesium deficiency and the value of orchard mulches. It is now planned to study the value of mineral leaf analysis in planning a fertilizer program for orchards. When unmistakable symptoms of a mineral deficiency appear, it is probable that much injury to the tree has already occurred. A knowledge of the mineral content of the leaf might suggest that certain elements were low and thus permit an earlier diagnosis of an approaching deficiency. The value of branch injections and leaf treatment as a means of diagnosis is also being studied.

The project has led to a gradually increasing appreciation of the value of potash and possibly phosphorus in the orchard; also to the belief that the so-called "complete" fertilizer is not complete. Magnesium, boron, and possibly calcium are as important as phosphorus and potassium to supplement the most

important element, nitrogen. No evidence of a deficiency of other than these six elements has yet been found in Massachusetts orchards. The value to the trees of some of these elements may be indirect in that they favor the growth of grass or cover crops and thus add humus and colloidal matter to the soil to benefit the trees.

A complete fertilizer and magnesium and boron may not be needed every year, as is nitrogen, but should be applied from time to time as orchard needs require. Magnesium limestone should always be used rather than a high calcium limestone when soil acidity drops below about pH 5.50. Boron in the form of borax should be applied to orchards that have shown deficiency, every 3 or 4 years at the rate of 30 to 50 pounds per acre. Boron in excess is toxic to plants, but apple and other tree fruits are not as sensitive to boron as are many other cultivated plants.

Blueberry Culture. (J. S. Bailey.) Mummy berry infection was reduced about 50 percent in 1945 by spraying four times with Fermate.[1] This work is being continued in 1946.

DDT and cryolite as dusts were applied to control the cranberry fruit worm. Since the infestation was very light, no significant differences were observed. However, it was determined that the fluorine on berries dusted June 13 with cryolite was well below the Federal tolerance.

Several new blueberry selections were added to the Experiment Station collection during the year.

The blueberry stunt, a virus disease, was found in Massachusetts in the summer of 1945. A careful survey was made of most of the larger plantings. In most cases where the disease was found the grower promptly removed all infected or suspicious bushes. This disease has probably been in Massachusetts for a number of years, but it does not appear to be spreading.

Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) After five years of manuring, there is still no evidence of any toxic effect of applications of manure as heavy as 20 tons per acre.

Several years' experience indicates that blueberries can be grown in a rather heavy sod provided plenty of nitrogen is applied and the plants are not in a situation where moisture becomes the limiting factor.

Much more chlorosis than usual appeared in some of the blueberry plantings in the early summer of 1946, following the application of ammonium nitrate in place of the usual sulfate of ammonia. This chlorosis is most noticeable on the varieties Sam and Pemberton.

Control of the Peach Tree Borer. (J. S. Bailey.) Paradichlorobenzene, ethylene dichloride, and propylene dichloride were applied again in the fall of 1945 at the standard dosages. Too few borers were present to make comparisons of effectiveness possible. Again there was no sign of injury resulting from any of the treatments. A very satisfactory emulsion of propylene dichloride in water was made by using oleic acid and triethanolamine.

Magnesium Deficiency in Massachusetts Apple Orchards. (J. K. Shaw and W. D. Weeks.) The typical leaf scorch characteristic of magnesium deficiency was rather uncommon in our orchards in 1945. Yet chemical analysis of the leaves showed a tendency for the magnesium content to be lower rather than higher. Trees which had been treated with dolomitic limestone held up better than others treated with Epsom salts. A possible explanation is that magnesium

[1]The results of this experiment will appear in Volume 47 of the Proceedings of the American Society for Horticultural Science.

may have been leached from the soil by the heavy rains of May and June, 1945, and that soil moisture continued ample through July and August so that little leaf scorch appeared. The problem of correcting magnesium deficiency is difficult, particularly with mature trees. We continue to recommend the use of magnesium sulfate in three or four sprays in early summer for immediate results and dolomitic limestone for more lasting effect. An enlarged program of study of this problem is under way.

Thinning Apples with Sprays. (J. K. Shaw.) In 1946 as in 1945, spring freezes interfered with attempts to thin apples by spraying in bloom, yet some results were obtained. Dowax, 1 gallon to 100, seemed to reduce set of Macoun but had little or no effect on five other varieties, including McIntosh. A commercial preparation of naphthalene acetic acid, 20 p.p.m., was more or less effective on several varieties and thinned certain crab varieties and Stark excessively. Applied at 30 p.p.m., it reduced the set of Wealthy about one third; not enough to eliminate some hand thinning. It caused considerable dwarfing and distortion of the leaves.

Two DN powders were used, both of which thinned several varieties quite effectively and caused much less leaf burning than did Elgetol used in 1944. There were generally not effective on McIntosh. It will not usually be necessary to thin McIntosh, but the unusually heavy bloom this year seemed to offer an opportunity to study this variety. It is evidently not easily influenced by blossom-thinning sprays. Naphthalene acetic acid was partially effective and caused little leaf distortion.

Because of the abnormally cold spring, it is not safe to draw many conclusions as to the value of blossom-thinning sprays. They are being used in commercial orchards and it seems probable that they will find increasing use as we learn more about them. Evidently the variety, stage of bloom, and possibly condition of the tree must be carefully considered.

Applications of naphthalene acetic acid and 2, 4-D at heavy concentrations in August to delay blossoming the following spring and thus escape frost damage seemed to have no certain effect. Applied at the time of fruit bud formation in May, it affected the leaves in the usual way and destroyed many fruit buds of Duchess but did not noticeably affect the buds of McIntosh and Wealthy. Neither material seemed to hasten the ripening and development of yellow color in Golden Delicious and McIntosh when the apples were dipped in various concentrations of the material in water.

Chemical Control of Poison Ivy and Other Weeds. (J. S. Bailey.) Several chemicals, including ammonium sulfamate and three formulations of 2, 4-D and some oils, were tried as herbicides for poison ivy, chokecherries, and American bamboo (*Polygonum Seiboldii* De Vriese). For poison ivy and chokecherry, ammonium sulfamate was superior to anything else tried. Nothing was effective on American bamboo. Ammonium sulfamate sprayed around young peach trees to eliminate grass and weeds killed the peach trees.

DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

Broodiness in Poultry. (F. A. Hays and Ruby Sanborn.) The chief objective has been to develop a line of Rhode Island Reds entirely free from the broody instinct. This goal has not yet been attained, largely because of the problem of deferred broodiness and the difficulties of adequate progeny testing of the breed-

ing males. A limited life span in birds also adds to the difficulties. Data indicate that females with broodiness deferred beyond the first laying year sometimes produce daughters that exhibit the broody instinct in their first year. Hens that only cluck without cessation of laying may transmit broodiness. The most recent data indicate that broody behavior often appears in the most intense winter layers.

The last complete generation was hatched in 1944 and completed their first-year record in 1945. Of the 66 pullets housed, 51 completed a full year. Only one exhibited the broody instinct, and that by a single period. These females are being tested for deferred broodiness.

Effectiveness of Selective Breeding to Reduce Mortality. (Regional Poultry Research Laboratory and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station, cooperating.) Results of three generations of inbreeding to produce high and low mortality lines, with mortality rate the sole basis of selection, will not be completed until November 1946. The data indicate a significant difference between the two lines. One disturbing feature is that the mortality rate in the low line always exceeds the mortality rate in the control line. Complete results are not yet available.

Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl. (F. A. Hays and Ruby Sanborn.) Particular attention has been given to methods of selecting breeders to raise the level of production. A seven-year study just completed (now in press) indicates that annual egg production is a very unsatisfactory criterion of the probable breeding value of hens in improved flocks.

Intensity of laying at all seasons of the year stands out as of highest importance in the station flock of Rhode Island Reds at the present time. Methods of measuring intensity and further evidence of its mode of inheritance are receiving special study.

At present, raising the average egg production of all daughters from the different families above 230 eggs averaging about 25 ounces to the dozen seems to depend upon higher intensity and greater freedom from winter pause.

Fertility Cycles in Males. (F. A. Hays.) Sex hormones have not proved effective in increasing natural fertility of old males in midwinter. The value of artificial light for this purpose will be studied further.

A Genetic Analysis of Rhode Island Red Color. (F. A. Hays.) This project has been concluded. General results indicate recessive genes controlling dark pigmentation.

Secondary and Adult Sex Ratio in Relation to Hatchability. (F. A. Hays.) Further data on sex ratio have been secured on high and low hatching lines. Sex has been recorded on dead embryos sufficiently advanced and upon all dead chicks up to sexual maturity. The two lines differ greatly in hatchability, and possible factors underlying this difference are being studied.

Supplementary Nutritional Factors for Distillers' By-Products. (F. P. Jeffrey, W. S. Ritchie, G. L. Woodside, and J. W. Kuzmeski.) The use of distillers' by-products in poultry breeding rations has received continued study, with special emphasis on the factor or factors in fish meal which have a supplementary value for hatchability. In a repeat trial, the use of 1.25 percent of fish meal as a supplement to the negative control gave disappointing results. The current trial shows that 2.50 percent red fish meal and 2.00 percent liver extract give equally good hatchability when supplementing the negative control.

Breeding for High and Low Incidence of Internal Defects in Hen's Eggs. (F. P. Jeffrey.) In the first generation, 769 Rhode Island Red pullets were produced from two separate lines of breeding. Breeders in line 1 were selected for freedom from blood and meat spots, blemished yolk, and fishy odor in their eggs. Breeders in line 2 were selected for a high incidence of these defects. Fertility and hatchability were excellent in both lines.

Breeding White Plymouth Rocks for Eggs and Meat. (F. P. Jeffrey.) Hatching eggs were secured from six prominent commercial breeders, and approximately 450 pullets will be housed this year. There was a wide variation among the strains, as shown by the following figures:

Hatchability of total eggs set	50 – 84 percent
Incidence of fast feathering	2 – 34 percent
Mortality to 8 weeks of age	2 – 16 percent
Pure white down	45 – 82 percent
Body weight at 8 weeks (Average of both sexes)	1.00 – 1.47 pounds

Poultry Housing Investigations. (W. C. Sanctuary and C. I. Gunness.) See report of Department of Engineering.

Methods of Feeding. (John H. Vondell.) This is the second year's study of methods of feeding layers. Three pens of 60 and 80 birds were hopper fed (free choice) laying mash, whole oats, and whole corn. Two pens were hopper fed laying mash and hand fed scratch feed to equal the amount of mash consumption. One pen was fed a complete all-mash. The test began September 28 and ran for twelve lunar months, with the following results:

	Hopper-fed	Hopper-fed and Hand-fed	All-Mash
Average egg production, percent	51.2	49.3	50.9
Mortality, percent	25.6	12.4	7.5
Feed consumption per bird, pounds	93.5	109.9	108.3
Feed cost per bird	$3.09	$3.68	$3.79
Net return per bird over feed cost	$3.39	$2.53	$2.62

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, O. S. Flint F. G. Sperling, M. K. Clarke, and O. M. Olesiuk.)

1. *Pullorum Disease Eradication.*[1] During the 1945-46 season, 1,259,623 samples, representing 630 chicken and turkey flocks, were tested. Compared with the previous season, 284,582 more samples and 101 more flocks were tested; but the average percentage of reactors was the same, 0.12. Progress in eradication of the disease is definitely evidenced by the fact that 95.3 percent of all birds tested are in 100 percent tested, non-reacting flocks. The average percentage of reactors was lower in flocks tested annually than in flocks tested for the first time or intermittently.

[1] A detailed report of the 1945-46 testing season has been published in Control Series Bulletin 128.

The testing results for turkeys are not so encouraging. A total of 21,473 birds, representing 103 flocks, was tested. Approximately 25 percent of the tested birds are in infected flocks. This situation may be improved through more persistent education regarding pullorum disease eradication and prevention.

During the past year natural pullorum infection was identified in pheasants for the first time in Massachusetts. The history of the flock showed that the rifected birds were part of a group of pheasants imported from a Midwestern State by a Massachusetts State Game Farm. This observation suggests that pheasants may be a potential hazard to pullorum-free flocks.

2. *Diagnostic Service.* During the calendar year of 1945, 4224 specimens were received in 939 consignments, of which 509 were delivered in person. This is the largest number of consignments and specimens ever examined in a single year. The specimens were classified as follows: 3340 chickens; 715 turkeys; 75 ducks; 24 rabbits; 11 bovine semen; 9 each of canine feces, pheasants, and pigeons; 5 fish; 4 guinea pigs; 3 each of canaries, swabs from horses, and swine; 2 each of swine organs and bovine organs; and 1 each of bovine fetus, canine, deer, fox, goat feces, junco, rat, robin, and sheep.

Coccidiosis, tumors, pullorum disease, infectious bronchitis, and fowl paralysis were the conditions encountered most frequently. On the basis of gross examination, the tumors were classified as follows:

Lymphocytoma	31	Carcinoma	4	Fibroma	1
Myelocytoma	14	Embryonal nephroma	4	Hematoma	1
Leukosis	8	Leiomyoma	2	Melanoma	1
Hemangioma	6	Myxoma	2	Neurogenic sarcoma	1
		Unidentified	2		

Avian tuberculosis was identified in three flocks. Fowl typhoid reappeared in serious proportions and 14 cases were called to the attention of the laboratory, 12 of which represented new known foci of infection and were located principally in two new areas. Fowl cholera was identified in 25 instances including 12 new premises. Fowl cholera was found also in turkeys, ducks, and a robin. The infection in the robin was believed to have originated from a flock of chickens on range where an acute outbreak of the disease was in progress. Newcastle disease was found in chickens in November, and 10 cases were identified before the end of the year. The recognition of this disease calls into question the diagnoses of infectious bronchitis made earlier in the year without the benefit of embryo inoculations.

An unusually large number of cases of poisoning in chickens was noted and confirmed by the Feed Control Service Laboratory when necessary. These included 1 arsenic; 9 coal tar, creosote oil, and derivatives; 4 salt; 1 cocoa bean; 1 kerosene; 1 naphthalene; and 2 phosphorus. Attempts to confirm the diagnosis of cocoa bean posioning by feeding a small quantity of beans and shells to three birds were unsuccessful, but other observations indicated that the beans were the source of injury.

The 715 turkeys were received in 154 consignments and represent nearly twice the number of the previous year and ten times that of ten years ago. Pullorum disease, enterohepatitis, rickets, and paratyphoid were the diseases encountered most frequently. Coccidiosis, ulcerative enteritis, and perosis were each recognized in eight instances. Fowl typhoid was found in six poults and in one bird five months of age.

3. *Flock Mortality Studies.* Necropsies were made on 256 birds (111 females, 144 males, 1 unidentified) from the flock hatched in the spring of 1944 and maintained at the College for genetic studies. In the females, tumors, reproductive disorders, kidney disorders, and fowl paralysis accounted for more than three-fourths of the mortaility. On the basis of gross examination, the tumors were classified as follows:

Lymphocytoma	11	Leukosis	2	Papilloma	1
Myelocytoma	4	Carcinoma	2	Unidentified	1
Leiomyoma	3	Hemangioma	2		

In males, cannibalism, bacterial and mycotic diseases, kidney disorders, and fowl paralysis were the conditions most frequently encountered, accounting for 60 percent of the deaths.

4. *Infectious Bronchitis.* During 1945, 228 flocks were enrolled in the infectious bronchitis control program, which was carried on in much the same manner as in 1944. Several flocks enrolled in 1944 did not continue the program in 1945 for reasons not reported by the owners.

The bronchitis problem was greatly complicated by the identification of the Newcastle disease in Massachusetts in November 1945. Since the symptoms and lesions of the two diseases are so similar, an accurate diagnosis is not likely without resorting to refined and tedious laboratory tests. A survey is in progress to determine the distribution and incidence of these two diseases. Investigations into the transmission of the virus have recently shown that the virus of Newcastle disease can be isolated from fresh eggs laid by flocks which are in the terminal stages of the disease. The potential and practical significance of this finding is being investigated. When more personnel becomes available, methods of control will also be studied.

5. *Farm Department Brucellosis Control and Eradication.* The laboratory tested 388 bovine and 22 porcine blood samples by the standard tube agglutination method during the 1945 calendar year.

Mastitis Testing Laboratory. The progress in the development of an adequate mastitis testing laboratory has been consistent with delays experienced in all activities where new personnel and equipment are necessary.

WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, In Charge

The members of the research staff of the Waltham Field State are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

PUBLICATIONS

Bulletins

428 Annual Report for the Fiscal Year Ending June 30, 1945. 71 pp. October 1945.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in field or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

429 Annual Molt in Rhode Island Reds. By F. A. Hays and Ruby Sanborn. 24 pp. illus. December 1945.

The primary objective of this study was to determine the value of molting behavior as a guide in selecting breeding stock. Attention is given to both males and females in exhibition-bred and production-bred Rhode Island Reds.

430 Postwar Readjustments in Massachusetts Agriculture. By David Rozman. 35 pp. illus. March 1946.

Among the various postwar readjustments leading to greater efficiency and lower costs, primary consideration should be given to the reconstruction of farm units to take full advantage of land resources.

431 Identification of Blueberry Varieties by Plant Characters. By John S. Bailey and Arthur P. French. 20 pp. illus. May 1946.

This bulletin describes some of the vegetative characteristics which are useful in identifying plants of blueberry varieties in the nursery. Familiarity with these characteristics should aid in the prevention of variety mixtures.

432 Black Root Rot Resistant Strains of Havana Seed Tobacco for the Connecticut Valley. By C. V. Kightlinger. 20 pp. illus. May 1946.

This bulletin reports attempts to develop a strain of Havana Seed tobacco satisfactorily resistant to black root rot, yet capable of producing high yields of good quality.

433 Weather and Water in Cranberry Production. By Henry J. Franklin and Neil E. Stevens. 51 pp. illus. June 1946.

This is a supplement to Bulletin 402, and together they are intended to cover our present understanding of cranberry weather and water relations.

434 Mushrooms—For Food and Flavor. By William B. Esselen, Jr., and Carl R. Fellers. 20 pp. illus. June 1946.

Laboratory studies prove that mushrooms, besides serving as a flavor or garnish for other foods, are a nutritious food in themselves.

435 Vegetative Propagation of White Pine. By William L. Doran. 16 pp. illus. July 1946.

The difficulties experienced in propagating white pines from cuttings can be largely overcome. This is a description of methods used and results obtained.

Control Bulletins

124 Twenty-fifth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 12 pp. July 1945.

125 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 32 pp. July 1945.

126 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 28 pp. September 1945.

127 Seed Inspection. By F. A. McLaughlin. 40 pp. December 1945.

Meteorological Bulletins

679-690, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

Reports of Investigations in Journals

NUMBERED CONTRIBUTIONS

521 Composition and nutritive value of mushroom protein. By William H. Fitzpatrick, William B. Esselen, Jr., and Edith Weir. Jour. Amer. Diet. Assoc. 22 (4):318-323. 1946.

523 A note on the presence of pyruvic acid in Ebenezer onions. By Emmett Bennett. Plant Physiol. 20 (3):461-463. 1945.

538 Studies in the chemistry of grass silage. By J. G. Archibald. Jour. Agr Res. 72 (8):277-287. 1946.

545 Influence of supplementary calcium and magnesium fertilizers upon nutritive value of kale. By Arthur D. Holmes, Leo V. Crowley and John W. Kuzmeski. Food Res. 10 (5):401-407. 1945.

548 The ascorbic acid, carotene, chlorophyll, riboflavin, and water content of summer squashes. By Arthur D. Holmes, Albert F. Spelman and Carleton P. Jones. Food Res. 10 (6):489-496. 1945.

550 Immunization against a lymphoid tumor of the chicken. I. Attenuation by freezing. By Carl Olson, Jr., Cornell Vet. 35 (3):221-230. 1945.

551 Immunization against a lymphoid tumor of the chicken. II. Use of centrifuged material. By Carl Olson, Jr. Cornell Vet. 35 (4):308-313. 1945.

552 Immunization against a lymphoid tumor of the chicken. III. Attenuation by heat, drying and chemicals. By Carl Olson, Jr. Cornell Vet. 36 (1): 41-47. 1946.

556 Isolating gene 'E' for early sexual maturity. By F. A. Hays. Amer. Nat. 79:372-377. 1945.

558 Further data on correcting magnesium deficiency in apple orchards. By Lawrence Southwick and C. Tyson Smith. Amer. Soc. Hort. Sci. Proc. 46:6-12. 1945.

561 Frost injury to trees. By Malcolm A. McKenzie. Trees 6 (3):10. 1945.

562 Venting times for community cannery-type retorts. By William H. Fitzpatrick, John E. McConnell and William B. Esselen, Jr. The Canner 101 (1):16-18; 101 (2):12-13. 1945.

564 Some notes on the mechanics of applying selective herbicides to vegetable crops. By William H. Lachman. Amer. Soc. Hort Sci. Proc. 46:323-328. 1945.

565 Ice cream as a source of riboflavin, carotene and ascorbic acid. By Arthur D. Holmes, John W. Kuzmeski, Carleton P. Jones and Frank T. Canavan. New England Jour. Med. 234:47-49. 1946.

566 Study of false presumptive tests from water treated with chlorine-ammonia. By James E. Fuller and Chas. K. Ewing. New England Waterworks Assoc. Jour. 59 (3):244-251. 1945.

568 Variation in bacteria, fat, ascorbic acid, and riboflavin content of commercial goat's milk. By Arthur D. Holmes, Harry G. Lindquist and Elliott K. Greenwood. Jour. Dairy Sci. 28 (11):853-858. 1945.

569 Some effects of thyroprotein on the composition of milk. By J. G. Archibald. Jour. Dairy Sci. 28 (12):941-947. 1945.

570 Utilization of Shrimp Waste. By Francis P. Griffiths. Nat'l Chemurgic Digest, August, 1945.

572 Propagation of the Briarcliff rose by cuttings. By William L. Doran. Florists' Exch. 105 (11): 17 and 21. 1945.

574 Vitamin content of field-frozen kale. By Arthur D. Holmes, Beula V. McKey, Katherine O. Esselen, Leo V. Crowley, and Carleton P. Jones. Amer. Jour. Dis. Children 70 :298-300. 1945.

575 Influence of incubation temperatures on differential tests of coliform bacteria. By James E. Fuller. Jour. Bact. 51 (4):457-464. 1946.

576 The vitamin content of mare's milk. By Arthur D. Holmes, Beula V. McKey, Anne W. Wertz, Harry G. Lindquist and Leonard R. Parkinson. Jour. Dairy Sci. 29 (3):163-171. 1946.

581 The control of the blueberry bud mite. By John S. Bailey and Arthur I. Bourne. Jour. Econ. Ent. 39 (1):89. 1946.

584 The application of chemistry to animal husbandry. By J. G. Archibald. Jour. Chem. Ed. 23:49-51. 1946.

587 The use of calcium salts in freezing McIntosh apples. By John J. Powers and William B. Esselen, Jr. Fruit Prod. Jour. and Amer. Food Mfr. 25 (7):200-202, 217. 1946.

591 Goat's milk as a source of bone building minerals for infant feeding. By Arthur D. Holmes, John W. Kuzmeski, Harry G. Lindquist and Henry B. Rodman. Amer. Jour. Dis. Children 71:647-653. 1946.

UNNUMBERED CONTRIBUTIONS

Minerals for dairy goats. By J. G. Archibald and S. A. Asdell. Better Goat-keeping 1 (2). September 1945.

The current feed situation. By J. G. Archibald. New England Homestead, January 12, 1946.

Soil fertility and animal health. By J. G. Archibald. Amer. Fert. 104 (7). April 1946.

Dutch elm disease in Massachusetts during 1945. By Malcolm A. McKenzie. New England Div. Amer. Phytopath. Soc. at New Haven, Conn., December 5, 1945. Abstracted for Phytopathology.

Role of riboflavin in poultry nutrition. By Arthur D. Holmes. Northeastern Poultryman, December 1945, p. 37.

Milk in the human dietary. By Arthur D. Holmes. Amer. Cookery, February 1946, p. 28.

Tansy causes off-flavor. By H. G. Lindquist. New England Homestead 118 (17):12. September 8, 1945.

Higher quality milk. By H. G. Lindquist. New England Goat News 8 (4):1, 3, 5-6; 8 (5): 3-4. April and May 1946.

Milk products in bread enrichment. By J. H. Frandsen. Natl. Butter and Cheese Jour. 36 (10):66, 1945. Certified Milk 20 (234):7, 18, 1945; Hoard's Dairyman 90 (19):541, 1945; Amer. Milk Rev. 7 (9):336, 1945.

Pests outside the four walls. By A. I. Bourne. Pests 13 (3):6-12. 1945.

DDT saves colonial coach at Amherst. By A. I. Bourne. Pests 13 (4):31. 1945.

Supply outlook for fungicides and insecticides in 1946. A. I. Bourne and O. C. Boyd. Fruit Notes, November 1945; Commercial Vegetable Grower, December 1945.

Leaf-feeding sawfly larvae burrowing in structural wood. W. B. Becker and H. L. Sweetman. Jour. Econ. Ent. 39 (3):408. 1946.

DDT, its uses in horticulture. By W. D. Whitcomb. Mass. Hort. Soc. Flower Show Program. March 1946. pp. 37-41.

MIMEOGRAPHED CIRCULARS

FM 19 Returns from poultry farming in Massachusetts in 1944. By Charles R. Creek. 17 pp. October 1945.

High costs and high returns on 50 dairy farms in Massachusetts. By Charles R. Creek. 5 pp. June 1946.

Standards for Massachusetts dairy farms (4 pp.); Standards for Massachusetts poultry farms (2 pp.); Standards for Massachusetts market garden farms (4 pp.); Standards for Massachusetts fruit farms (3 pp.). By Charles R. Creek. Revised August 1945.

Dutch elm disease. By Malcolm A. McKenzie. Five progress reports.

Progress reports issued under the National Cooperative Project, Conservation of Nutritional Value of Foods:
Effect of containers and other factors on the ascorbic acid content of processed tomato juice. By W. B. Esselen, Jr., and R. A. Woodward. 3 pp. 1945.

Extension Publications

The following Extension Leaflets and Circulars were prepared wholly or in part by members of the Experiment Station staff:

Improving land the modern way. By Charles R. Creek and Joseph F. Hauck. Special Circular 122. 1945.

Cost figures on boulder removal. Farm Economic Facts, March 1946.

High costs—high returns. By C. R. Creek. Farm Economic Facts, June 1946.

Minerals for dairy cattle. By J. G. Archibald. Leaflet 236. 1945.

Winter injury to trees. By Malcolm A. McKenzie, Special Circular 117, revised.